MICRO DECISION-MAKING IN EVERYDAY LIFE: AN INVESTIGATION WITH SUBJECTIVE EVIDENCE-BASED ETHNOGRAPHY

ATRINA ORAEE

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DECLARATION

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

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ABSTRACT

Micro Decision-Making (MDM) refers to the numerous, small-scale decisions individuals make daily. However, the subjective experience and micro-processes underlying MDM in natural settings remain largely unexplored. To address this gap, we employed Subjective Evidence-Based Ethnography (SEBE), a methodology combining first-person video recordings with wearable video glasses (subcams), self-confrontation interviews, and detailed activity analysis to capture the moment-to-moment dynamics, contextual factors, and subjective processes involved in everyday MDM. Approximately 50 hours of first-person perspective recordings from 51 UK adults aged 22-60 engaged in typical daily activities such as cleaning, cooking, commuting, organising, and grocery shopping were collected, then analysed in detail and coded with the participants themselves. We developed a novel participative coding system, the Reinforced Replay Interview (RRIW), which enables the identification of reorientation and MDM instances based on participants' subjective experiences, addressing a critical limitation in previous decision-making (DM) research that relied on self-reported data or memory, or external interpretation.

We identified specific behavioural variables, such as pausing, hesitation, and scanning, that serve as observable markers of MDM instances. Their occurrence and combination reflect shifts between semi-automatic and deliberate processing modes. By analysing over 2700 instances of breaks in the flow of activity, of which around 84% were labelled by participants as connected with a "decision", we built a grounded model of how the activity is oriented at the microscopic level. Our findings challenge and refine traditional DM models, such as rational choice theory and dual-process accounts; they provide an informed picture of how micro-decisions intertwine with the activity flow where the actor's activity is channelled and fluidly coupled with the context. We forward the explanation that activity is controlled by prediction-error detection processes, where attention, exploration and reasoning are scarce resources that are mobilised only when necessary.

With unprecedented, very detailed, material collected in natural settings and interpretations validated by the participants themselves, this thesis contributes to the body of research on naturalistic DM by providing a rich, contextualised description and understanding of the subjective experiences and micro-processes underlying MDM in everyday life. Its insights have important implications for developing interventions.

Keywords: Micro decision-making, Subjective experience, Everyday life, Subjective Evidence-Based Ethnography (SEBE), Naturalistic decision-making, Choice architecture, Activity theory, Installation theory, Dual-process, Flow.

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LIST OF ABBREVIATIONS

DM	Decision-Making
SEBE	Subjective Evidence-Based Ethnography
RIW	Replay Interview
MDM	Micro Decision-Making
NDM	Naturalistic Decision-Making
IAT	Implicit Association Test
RPD	Recognition-Primed Decision
RRIW	Reinforced Replay-Interview
TA	Thematic Analysis
AI	Artificial Intelligence
ML	Machine Learning
RL	Reinforcement Learning

1 INTRODUCTION

Decision-making (DM) is a fundamental aspect of human life, and its processes have been the subject of extensive research across various disciplines, including psychology, economics, and neuroscience. The importance of understanding how people make decisions has been increasingly recognised, as evidenced by the awarding of the 2002 Nobel Prize in Economic Sciences to Daniel Kahneman for his work on heuristics and biases (Kahneman & Tversky, 1979, 1982; Tversky & Kahneman, 1981, 2016) and the growing influence of behavioural economics and policy applications of "nudges" (Thaler, 2016; Thaler & Sunstein, 2008).

Recent advancements in neuroscience have provided insights into the DM process and the relationship between will, consciousness, and action (Haggard, 2019; Maloney & Mamassian, 2009). However, as research methods become more sophisticated, they tend to rely more heavily on laboratory settings. As a consequence, many classifications of DM are not based on empirical evidence from real-world situations, which limits their ecological validity. Then, research tends to focus on specific types of (simple) decisions that are suitable for experimental designs (e.g., decisions that can be easily described in a questionnaire), raising questions about their representativeness of the diverse types of decisions encountered in everyday life. This work is an attempt to complement these experimental and laboratory studies with empirical evidence from activity in natural contexts.

Studying DM in natural settings requires understanding what we need to observe. In experiments, the experimenter defines the “decision”, but in natural settings, identifying what constitutes a decision is less clear. For example, the boundary between habitual behaviour and conscious DM is not well-defined. When do we "make the decision" to take the lift instead of the stairs? And do we consciously "decide" to press the elevator button? In practice, the fundamental nature of DM remains unclear. Furthermore, our understanding of the subjective experience of DM, including our thoughts, feelings, and how we represent and describe the decision process to ourselves and others, is limited. These questions have been understudied due to the difficulty in capturing ecological data and the methodological challenges associated with introspection. Using a technique that enables detailed analysis of both behaviour and subjective experience, this research explores how humans orient their behaviour in the detail of everyday life, a process we shall call, provisionally, micro-decisions.

This grounded approach addresses a gap that DM theorists have long pointed to. Weiss and Shanteau (2021), prominent figures in the field noted that the field of judgment and DM has primarily focused on testing models, with experimentation dominated by the gambling paradigm as a questionable metaphor for real life, and that this emphasis on experimentation, testing, and precision has come at the cost of realism, highlighting the need for a naturalistic study of human behaviour to explore the various types of decisions involved in everyday life. However, doing so is a technically challenging task, and most studies to date have relied on memory (Gore et al., 2018; Hutchinson et al., 1991), which is known to be unreliable (Anderson et al., 1996; Thompson et al., 2014).

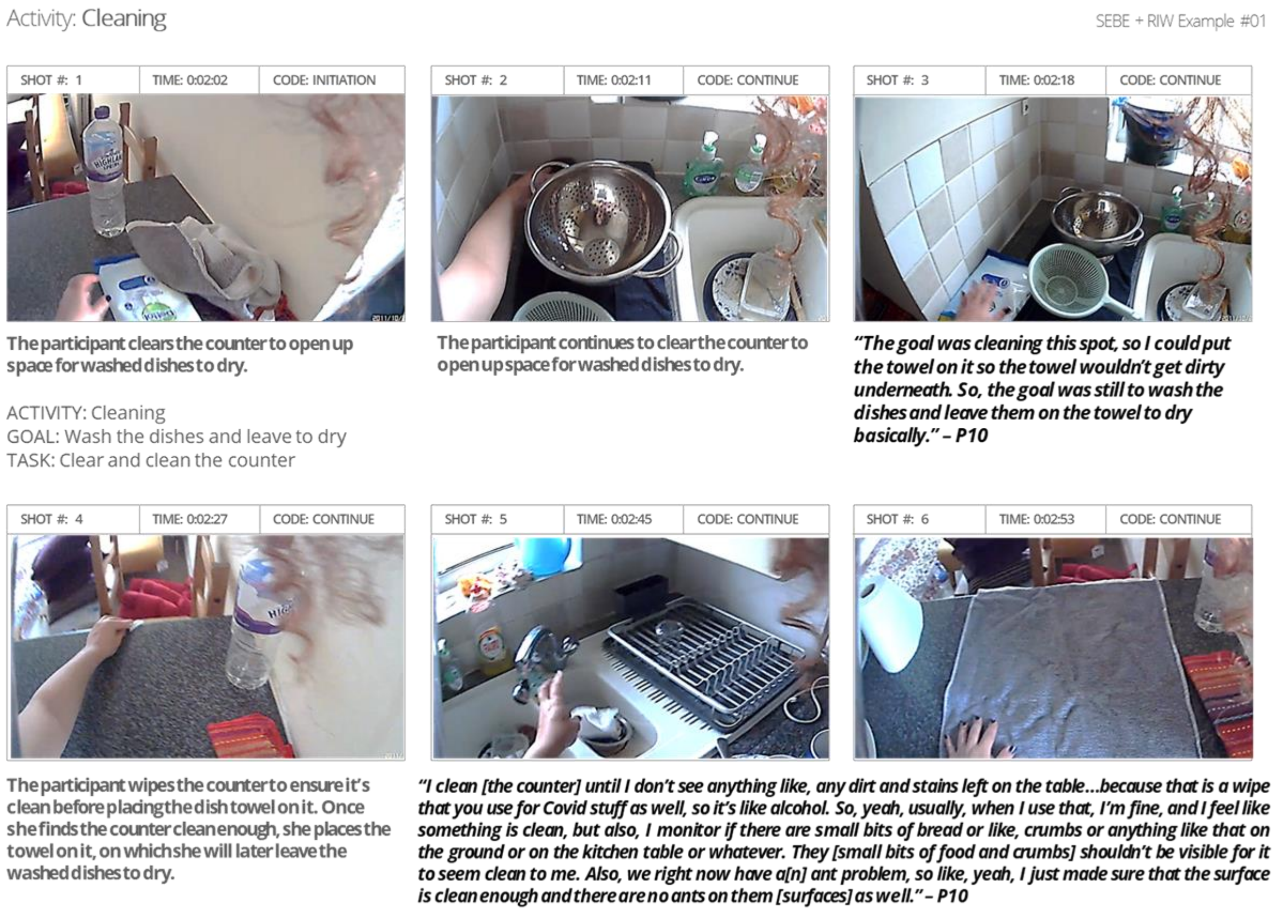
To address these methodological challenges and investigate the subjective experience of DM using real-time data, this research employs the Subjective Evidence-Based Ethnography (SEBE) approach (Lahlou et al., 2015). SEBE is an innovative methodology that combines first-person perspective video recordings, Replay Interviews (RIW), and detailed activity analysis to capture the subjective experience of individuals in natural contexts. Participants wear a small, unobtrusive camera that records their first-person perspective as they go about their daily activities. The first-person recording obtained, wide-angle, high resolution and stereo sound, is called a "subfilm". This approach allows for capturing real-time, situated data on DM processes as they unfold in everyday life. After the recording session, participants engage in a RIW, where they watch their first-person video (the subfilm) and provide a detailed commentary on their thoughts, feelings, and DM processes at each moment (see Research Design chapter, page 51, for details). This RIW is also fully recorded on video, in order to record the details of the film that the participant comments on the screen (and usually points with their finger or mouse).

Our methodology offers several advantages over traditional approaches to studying DM. First, it captures DM *in situ*, providing a more ecologically valid and contextually rich understanding of how people make choices in their natural environments. Second, by recording a first-person perspective video, SEBE minimises the reliance on retrospective reports and memory. Third, the self-confrontation interview allows for a detailed exploration of the subjective experience of DM, providing insights into the thoughts, feelings, and representations that guide individuals' choices. This form of self-reflection, done *after the fact* but based on empirical evidence and re-enactment, allows participants to provide introspective comments about actions that were natural and unaffected by the observation process. This differs from methods like thinking aloud or experience sampling, where the act of observation can interfere with the behaviour.

Our study deliberately focuses on mundane, everyday activities rather than high-stakes or critical decisions. This choice was made following our exploratory phase and pilot studies, which revealed several advantages to this approach. Firstly, participants demonstrated greater willingness to share footage of routine activities via subcams, likely due to the lower perceived privacy risks compared to more sensitive contexts. This increased openness allowed for richer, more natural data collection. Secondly, studying everyday activities circumvented major ethical issues or considerations that might arise with more critical DM scenarios, enabling a smoother research process. Importantly, we found that everyday mundane activities, such as cleaning, cooking, or commuting, were remarkably similar across all participants regardless of their backgrounds. This commonality provides an excellent proxy for studying everyday behaviour, as these activities are universally engaged in, albeit with cultural and individual variations. Moreover, these everyday activities are predominantly physical in nature, making them ideal subjects for subcam studies. The visual and tactile aspects of tasks like cleaning, cooking, or organising are well-captured by first-person video, allowing for detailed observation of the activity and DM processes involved in these tasks. By focusing on routine decisions, we can capture the cumulative impact of numerous small choices that, while seemingly insignificant in isolation, collectively shape our daily lives and long-term outcomes. This approach also allows us to study DM processes in their most natural, unaltered state, free from the artificial pressures or self-consciousness that might arise in more high-stakes scenarios. Lastly, examining mundane activities offers insights into the development and application of heuristics and habitual DM patterns that form the backbone of our daily cognitive functioning. By understanding these processes in everyday contexts, we shed light on the foundations of more complex or critical DM scenarios.To illustrate, here is an example. The below image is extracted from the subfilm and RIW sessions through which P10 decided to tidy up and clean the kitchen. To this end, she clears and wipes the counter next to the sink to leave the washed dishes to dry later. She explained the process, including how she evaluated the cleanliness of the counter. The entire sample of data collected through the SEBE protocol for P10 can be viewed via the following link: https://shorturl.at/ByMYq. Moreover, the extended version of the transcription can be viewed in Sample Replay Interviews. As can be seen, the degree of detail obtained through this protocol is far beyond what can be obtained with the classic techniques.

Figure 1

An example of the subfilm with the participant's explanations embedded.



Note. The participant has decided to tidy up and clean the kitchen. To achieve this goal, she clears and wipes the counter next to the sink to let the washed dishes dry. She finally places the dish towel on the counter for later.

The primary aim of this study is to investigate how individuals experience different types of decisions in their everyday lives. Given the vast scope of this topic, we narrow our focus to micro-decisions, which are the numerous, small-scale choices people make throughout their day, often without much conscious deliberation. These decisions, while seemingly minor in isolation, can have significant cumulative effects on individuals' lives and well-being. By capturing Micro Decision-Making (MDM) processes as they occur in real-world contexts using the SEBE methodology, this research aims to provide an ecologically valid and phenomenologically grounded understanding of everyday DM, shedding light on the subjective experiences, thought processes, and contextual factors that shape these choices.

The subcam methodology has been successfully employed in various research contexts, demonstrating its versatility and potential for capturing naturalistic DM processes. Hollan and Hutchins (2009, 2010) utilised subcams to examine the activity of pilots, providing insights into DM in complex, high-stakes environments. Le Bellu, Lahlou, and colleagues (2010) explored the potential of subcams in transferring experience in high-technology areas, developing protocols for expertise tracing and transfer in real work conditions for novice training.

In the realm of professional practice, Rieken (2013) and Stangeland (2016) employed subcams to study police DM under pressure, offering a first-person perspective on law enforcement practices. Heptonstall (2015) and Zhang (2015) applied the methodology to investigate DM processes in Intensive Care Units, shedding light on medical DM in critical care contexts.

Subcams have also been used to explore consumer behaviour, with Gobbo (2014) examining DM processes in evaluating goods. In the domain of digital behaviour, Everri (2017) and Heitmayer and Lahlou (2021) utilised subcams to study social media use and addictive behaviour, while Heitmayer (2021) investigated locked smartphone use among young adults.

The present study builds upon this body of work by applying the subcam methodology specifically to MDM in everyday life. While previous studies have often focused on specialised or high-stakes DM contexts, this research extends the application of subcams to mundane, daily activities. Doing so aims to capture the nuanced, moment-to-moment decision processes that characterise our everyday lives, providing a more comprehensive understanding of how people navigate routine choices and challenges. This approach allows for a unique exploration of DM "in the wild", addressing gaps in our understanding left by more controlled, laboratory-based studies.

While our study primarily focuses on individual DM processes in everyday activities, it's important to note that we have intentionally minimised the role of social interactions. This decision was made for several reasons. Firstly, social interactions introduce a level of complexity that would require an entirely separate study to fully explore and understand. The dynamics of interpersonal communication, social influence, and collaborative DM are vast topics in their own right, each deserving dedicated research. Secondly, by focusing on individual activities, we were able to maintain a clearer focus on the internal cognitive processes involved in MDM, without the added variable of social influence. However, we recognise the importance of social context in DM, and have not entirely excluded it from our study. As illustrated in our analysis of a dialogue between a couple of participants collaborating together for cleaning purposes (see Section 5.3, page 117), we have provided some insight into how social interactions can influence decision processes in household activities. This example serves as a springboard for future research, highlighting the potential for extending our methodology to more socially-embedded DM contexts. By acknowledging this limitation, we hope to encourage future studies that can build upon our findings to explore the intricate interplay between individual cognition and social dynamics in everyday DM.

Moreover, it is important to acknowledge that this thesis draws upon theories and concepts from various disciplines and epistemological backgrounds. We are acutely aware of the potential inconsistencies that may arise from juxtaposing these diverse perspectives. Our intention is not to reconcile these differences or to criticise any particular theory but rather to test our observations across a range of theoretical frameworks and disciplines. This approach allows us to explore how our findings align or misalign with the current understanding of DM processes.

The core of this research is qualitative in nature, focusing on rich, detailed observations of DM in real-world contexts. While we do employ some quantitative analyses, these are used sparingly and cautiously to provide perspective on our findings. We refrain from drawing definitive conclusions from these quantitative elements, recognising the limitations of our sample size and the exploratory nature of our study.

It is crucial to note that our research methodology differs significantly from many previous DM studies. Rather than limiting the problem space or creating controlled scenarios, we observe MDM as it naturally occurs in everyday life. This approach yields data that is fundamentally different from that typically used in decision science research. Our study is inherently empirical, prioritising real-world observations over theoretical constructs.

Again, the primary aim of this research is not to critique existing theories, as we are working with naturalistic data that differ from those used in experimental studies or surveys; but to present our observations and findings, examining how they relate to established frameworks in decision science. By doing so, we hope to contribute to a more comprehensive understanding of DM processes, particularly in the context of everyday life.

We believe that this approach, while challenging in its breadth, offers valuable insights into the complex, nuanced nature of real-world DM. It is our hope that by acknowledging the epistemological complexities and methodological differences upfront, readers will be better equipped to engage with our findings in a constructive and nuanced manner.

We start the thesis by reviewing the literature (see Chapter 2, Literature review), which provides a wide and interesting view of the various angles from which the problem has been approached so far and shows the various layers, from physiological to logical, of the processes involved in various forms of DM.

This review also reveals significant gaps in our understanding of DM in everyday life. These include the limited ecological validity of laboratory studies, the neglect of individual differences and contextual factors, and the fragmentation of research across different theoretical perspectives and methodological approaches.

We review the relevant literature comprehensively throughout Chapter 2, covering key theories and approaches in DM research, from rational choice theory to more recent perspectives such as NDM and MDM in everyday life. Chapter 2 also introduces Activity Theory and Installation Theory as relevant frameworks for understanding intentional and situational influences on DM. Chapter 3 identifies the research gap in our understanding of MDM in everyday contexts and outlines our research angle. Chapter 4 details our research design, including the exploratory, pilot, and main study stages. It describes our innovative methodology, including using SEBE, RIWs, and Reinforced Replay Interviews (RRIW). Chapter 5 presents our research findings, covering empirical results, behavioural indicators of MDM, the relationship between activities and MDM, and a synthesis of core findings. Chapter 6 discusses these findings in depth, exploring various activity components and behavioural indicators and proposing a non-linear model of MDM. Finally, Chapter 7 concludes the thesis by summarising key findings, discussing implications and future research directions, acknowledging limitations, and providing overall conclusions.

In summary, this thesis explores the subjective experience of MDM in everyday life using very detailed empirical evidence recorded in first-person perspective, in naturalistic settings. By capturing the moment-to-moment dynamics, contextual factors, and subjective processes that shape real-world MDM, this research aims to bridge the gap between laboratory studies and naturalistic choice situations, providing a more ecologically valid and phenomenologically grounded understanding of DM processes.

2 LITERATURE REVIEW

2.1 OVERVIEW

As recognition for the significance of DM grew, research in this interdisciplinary field resulted in numerous findings, theories, and prescriptions over the past half-century, looking into the processes people enact when making choices. As a result of such scientific endeavours, the DM literature is massive. This literature review chapter traces the historical development of DM research, focusing on the methodologies and tasks employed to investigate how people make choices. Starting with the seminal work of von Neumann and Morgenstern (1947) on rational choice theory, the review explores the progression from highly structured, artificial tasks used in early descriptive research to more ecologically valid and naturalistic methods in recent years. By examining this trajectory, we aim to illuminate the gap between the precision of formal models tested with simplistic tasks and the rich complexity of real-world decision contexts.

The chapter highlights the contributions and limitations of key research paradigms, including the heuristics and biases program, prospect theory, process-tracing techniques, and behavioural economics. We also discuss the emergence of Naturalistic Decision-Making (NDM) research and the increasing use of field experiments, digital trace data, and simulations to capture decision processes in situ. Throughout the review, we emphasise the tension between internal and external validity as researchers seek to balance experimental control with the generalisability of their findings to everyday choice situations. We argue for greater integration of insights from adjacent disciplines and the development of more comprehensive, context-sensitive theories and methods to bridge the gap between laboratory studies and real-life DM. To conclude the review of the most relevant literature to our research, Activity Theory and Installation Theory are reviewed as a couple of the core theories this research builds on and utilises as frameworks for behavioural and activity analyses.

2.2 EARLY DECISION-MAKING RESEARCH: RATIONAL CHOICE THEORY AND ITS LIMITATIONS

The DM research field is rooted in the seminal work of von Neumann and Morgenstern's (1947) landmark volume on rational choice theory. This sparked an interdisciplinary collaboration to study how people make choices, with early descriptive research by psychologists focusing on highly structured tasks that could identify optimal or rational behaviour. Edwards (1954) highlighted the field's commitment to studying the properties of researcher-designed tasks and individuals' responses to them.

Rooted in the rational choice tradition (Edwards, 1954; Neumann & Morgenstern, 1947), early DM research emphasised the role of stable, context-independent preferences in guiding choice. This perspective assumes that people have well-defined, consistent preferences that are revealed through their choices and that situational factors play a minimal role in shaping these preferences (Friedman, 1953; Samuelson, 1938). Such studies used simple gambles and other stylised tasks to reveal regularities in DM, such as people's lack of insight into their own decision processes and their tendency to over- or under-utilise information (Slovic et al., 1977). For example, Mosteller and Nogee (1951) used two alternative forced-choice tasks with gambles to measure utility, while Tversky (1969) employed similar tasks to demonstrate the intransitivity of preferences. In general, the tasks employed by such research included the below examples:

- Two alternative forced-choice tasks: Participants are presented with two options and had to choose one. These options could be simple gambles (e.g., a sure win of $10 vs. a 50% chance to win $25), consumer products, or hypothetical scenarios. The choices are often constructed to test adherence to axioms of rational choice theory, such as transitivity or independence of irrelevant alternatives (Mosteller & Nogee, 1951; Tversky, 1969).
- Probability estimation tasks: Participants are asked to provide numerical judgments of the likelihood of events, such as the probability of a specific team winning a game or the chances of a hypothetical person having a disease given a set of symptoms. These judgments are then compared to objective probabilities or Bayesian norms to assess calibration and over/underconfidence (Alpert & Raiffa, 1982; Slovic et al., 1977).
- Multi-attribute choice tasks: Participants are presented with options characterised by multiple attributes (e.g., cars varying in price, mileage, and reliability) and must choose their preferred alternative. The attribute values are often systematically manipulated to test for violations of normative principles like dominance or invariance (Payne, 1976; Slovic & MacPhillamy, 1974).
- Risky choice problems: Participants choose between gambles or investments that vary in probabilities and payoffs. Examples include the "Allais paradox" (choosing between a sure win and a risky bet with equal expected value) and the "Ellsberg paradox"

(choosing between gambles with known vs. ambiguous probabilities) (Allais, 1953; Ellsberg, 1961).

- Intertemporal choice tasks: Participants choose between smaller, sooner rewards and larger, later rewards (e.g., $10 today vs. $15 weekly). These tasks are used to study time discounting and present bias (Ainslie, 1975; Thaler, 1981).

While these tasks allowed researchers to test specific hypotheses and develop precise mathematical models, they were often criticised for their simplicity, artificial nature, and lack of resemblance to real-world decision contexts. Later research aimed to incorporate more realistic and complex stimuli while still maintaining experimental control.

While rational choice theory provides a clear, mathematically tractable model of DM, its strengths are also its limitations. The theory's simplicity and normative power make it an attractive framework for predicting behaviour under ideal conditions. However, its assumptions of perfect information, stable preferences, and unlimited cognitive capacity rarely hold in real-world scenarios. The theory struggles to account for the influence of emotions, social contexts, and cognitive limitations on DM. Moreover, its focus on outcomes rather than processes limits our understanding of how people actually arrive at decisions, particularly in complex, dynamic environments. Despite these limitations, rational choice theory remains a valuable baseline against which to compare more descriptive models of DM.

The progression from rational choice theory to the heuristics and biases approach marks a significant shift in our understanding of human DM. While rational choice theory provided a normative model of how people should make decisions under ideal conditions, the heuristics and biases program revealed the systematic ways in which actual human DM deviates from these rational ideals. This transition highlighted the importance of cognitive limitations and contextual factors in shaping decision processes. However, both approaches share a common limitation: they primarily rely on controlled, often hypothetical scenarios that may not fully capture the complexity of real-world DM. The artificial nature of many experimental tasks used in these studies (e.g., monetary gambles and probability estimations) raises questions about their ecological validity and generalisability to everyday decision contexts. Furthermore, these approaches tend to focus on the outcomes of decisions rather than the moment-to-moment processes that lead to those outcomes. This leaves a significant gap in our understanding of how people navigate the myriad of small decisions they face in their daily lives, particularly in naturalistic settings where decisions are often made quickly, under uncertainty, and with limited information. The next wave of decision research would need to address these limitations by developing methods to study DM 'in the wild' and capturing the dynamic, contextual nature of everyday choices.

2.3 HEURISTICS AND BIASES: CHALLENGING THE RATIONAL CHOICE PARADIGM

Recognising the difficulty of achieving perfect rationality due to cognitive limitations and the influence of environmental constraints on decision processes, Herbert Simon (1972) introduced the concept of "bounded rationality" - a theory that makes modest demands on human computational abilities when making choices. Simon's contributions suggest how the logical theory of rational choice could be encompassed within a more general framework that can deal more adequately with behaviour in complex, non-validated choice situations.

The study of judgment heuristics and biases, using Bayesian analysis to identify deviations from optimality, emerged with the work of Tversky and Kahneman (1974). They employed probability estimation tasks (Alpert & Raiffa, 1982) and risky choice problems like the "Allais paradox" (Allais, 1953) to lay the foundation for the heuristics and biases research program. Kahneman and Tversky (1979) then developed Prospect Theory to explain “irrational”choice patterns violating expected utility theory, using monetary gambles and hypothetical scenarios to demonstrate phenomena like loss aversion and framing effects. These findings highlighted the role of cognitive factors in DM, such as the use of heuristics, the influence of problem representation, and the constructive nature of preferences (McDaniels et al., 1995). This line of research further emphasised the role of situational factors in DM. Their research demonstrated that the framing of problems heavily influences people's judgments and choices (Tversky & Kahneman, 1981), with the availability of information (Tversky & Kahneman, 1973), and the presence of irrelevant anchors (Tversky & Kahneman, 1974). These findings suggested that preferences are constructed in response to situational cues rather than being stable and context-independent (McDaniels et al., 1995; Slovic, 2006). Tversky and Kahneman used a variety of tasks in their seminal work on judgment heuristics, biases, and Prospect Theory. These tasks were designed to reveal systematic deviations from normative principles of probability, logic, and rational choice. Below are some examples of the tasks they used in their seminal work.

Judgment Heuristics and Biases:

- Representativeness heuristic: Tversky and Kahneman (1974) used a "Linda problem" to demonstrate the representativeness heuristic. Participants were given a description of Linda, a fictitious person who resembled a feminist and asked to judge whether she was more likely to be a bank teller or a bank teller and a feminist. Many participants committed the conjunction fallacy, judging the conjunction of events (bank teller and feminist) as more probable than a single event (bank teller), violating the principles of probability theory.
- Availability heuristic: Tversky and Kahneman (1973) asked participants to estimate the frequency of various causes of death (e.g., heart attacks, accidents, cancer) and found that their estimates were influenced by the ease with which instances of these events could be recalled or imagined, rather than by their actual frequency. This demonstrated the availability heuristic, where the perceived likelihood of an event is influenced by the ease with which it comes to mind.
- Anchoring and adjustment: Tversky and Kahneman (1974) asked participants to estimate the percentage of African countries in the United Nations after providing them with an arbitrary anchor (e.g., 10% or 65%). Participants' estimates were biased towards the anchor, even when it was clearly irrelevant to the judgment task, demonstrating the anchoring effect.

Prospect Theory:

- Risky choice problems: Tversky and Kahneman (1979) used simple gambles and hypothetical choice problems to demonstrate key features of Prospect Theory. For example, they presented participants with a choice between a sure gain of $500 and a 50% chance to win $1000 (or nothing). Most participants preferred the sure gain, demonstrating risk aversion for gains. However, when presented with a choice between a sure loss of $500 and a 50% chance to lose $1000 (or nothing), most participants preferred the gamble, demonstrating risk-seeking for losses.
- Framing effects: Tversky and Kahneman (1981) used framing problems to show how the description of options influences choice. In the "Asian disease problem," participants were asked to choose between two treatment options for a disease outbreak. When the options were framed in terms of lives saved, participants preferred the certain option, but when the same options were framed in terms of lives lost, participants

preferred the risky option. This demonstrated that preferences are not invariant to the framing of options, violating the principle of invariance in rational choice theory.

- Loss aversion: Tversky and Kahneman (1991) used simple choice problems to demonstrate loss aversion, the idea that losses loom larger than gains of equal magnitude. For example, they found that most people would not accept a gamble with a 50% chance to win \$150 and a 50% chance to lose \$100, even though the expected value of the gamble is positive. This suggests that the disutility of losing \$100 is greater than the utility of winning \$150, consistent with loss aversion.

These tasks and problems, while often simple and hypothetical, were carefully designed to reveal systematic biases in human judgment and DM. They played a crucial role in challenging the assumptions of rational choice models and paving the way for new descriptive DM theories under uncertainty.

Gerd Gigerenzer and his colleagues have made significant contributions to the study of heuristics in DM as a contrasting perspective that emphasises the adaptive value of heuristics. They offer a perspective that diverges from the heuristics and biases program of Tversky and Kahneman with an approach that highlights the ecological rationality of heuristics and their potential to make accurate decisions with limited time and information. Gigerenzer's work emphasises the adaptive value of heuristics as "fast and frugal" strategies that can lead to accurate decisions under conditions of limited time, information, and cognitive resources (Gigerenzer, 2008; Gigerenzer & Gaissmaier, 2010; Gigerenzer & Goldstein, 1999). Here, we review some key aspects of Gigerenzer's heuristics research:

- Ecological rationality: Gigerenzer argues that the rationality of heuristics should be evaluated in terms of their ecological rationality or their fit with the structure of the environment in which they are used (Gigerenzer & Todd, 1999a). He suggests that heuristics can be effective when they exploit stable regularities or information cues in the environment, even if they violate normative principles of probability or logic (Goldstein & Gigerenzer, 2002). We review this perspective as a counterpoint to the notion of heuristics and biases, which emphasises the deviations of heuristics from normative standards.
- Recognition heuristic: Gigerenzer and Goldstein (1996) proposed the recognition heuristic, which states that when faced with a choice between two options, one of which is recognised and the other is not, people will infer that the recognised option has a higher value on the criterion of interest. They demonstrated that this simple heuristic

can lead to accurate judgments in domains like city population size, where recognition is correlated with the criterion. This can be taken as an example of how heuristics can exploit information structures in the environment to make accurate decisions with minimal cognitive effort.

- Take-the-best heuristic: Gigerenzer and Goldstein (1996) also introduced the take-the-best heuristic, a lexicographic strategy for making inferences based on a series of binary cues. The heuristic searches for cues in order of their validity, stops when it finds a cue that discriminates between the options and chooses the option favoured by that cue. Gigerenzer and Goldstein showed that take-the-best can outperform more complex statistical models in predicting real-world outcomes like city population size and high school dropout rates, demonstrating how simple, non-compensatory strategies can be effective in certain decision environments.
- Fast and frugal trees: Gigerenzer and his colleagues have also developed fast and frugal decision trees, which are simple sequential decision rules that can be used for classification and DM (Hafenbrädl et al., 2016). These trees involve a series of binary questions that lead to a decision, and they often outperform more complex models in terms of accuracy and speed. They demonstrated how heuristics can be formalised and applied in practical decision contexts, such as medical diagnosis and criminal profiling.
- Heuristics in social contexts: Gigerenzer and his colleagues have extended the study of heuristics to social contexts, examining how simple strategies can be used for mate choice (Todd et al., 2007), moral judgment (Gigerenzer, 2010), and cooperation in social dilemmas (Hertwig & Herzog, 2009). These applications demonstrate the broad relevance of heuristics beyond individual DM and how the study of heuristics has expanded to encompass social and interpersonal processes.

Other research on the cognitive processes underlying DM advanced with process-tracing methods like think-aloud protocols (Payne, 1976), information boards (Bettman & Park, 1980), and eye-tracking (Russo & Rosen, 1975). These studies used consumer choice tasks, hypothetical scenarios, and gamble problems to provide evidence for contingent decision strategies (Payne, 1982), constructive preferences (McDaniels et al., 1995), and effort-accuracy trade-offs (Johnson & Payne, 1985). For example, Payne (1976) employed multi-attribute choice tasks with process tracing to reveal adaptive decision strategies, while Slovic and Lichtenstein (1968) used information boards to study cue utilisation in comparative judgments.

In parallel, the role of emotions in DM gained attention, challenging the assumption of purely rational choice. Zajonc (1980) argued for the primacy of affect in judgment, while Schwarz and Clore (1983) demonstrated the influence of mood on evaluative judgments. Loewenstein (1996) proposed the "risk-as-feelings" hypothesis, emphasising the role of anticipatory emotions in risky choice. Damasio's (1996) somatic marker hypothesis suggested that emotional signals guide DM by marking options as favourable or unfavourable. Luce, Payne, and Bettman (1999) studied the role of emotional trade-off difficulty in high-stakes choices like cancer treatments and child custody cases, finding that decision-makers often avoided emotionally difficult trade-offs.

Research on the cognitive processes underlying DM has employed a variety of tasks to study phenomena such as information search, strategy selection, and effort-accuracy trade-offs. Below are some examples of tasks commonly used in this area:

- Information board tasks: Participants are presented with a matrix of information about different choice options and their attributes. They can access information by opening cells in the matrix, and their pattern of information search is recorded. For example, Payne (1976) used an information board task to study the decision strategies people use when choosing among apartments, varying on attributes like rent, size, and location.
- Mouselab tasks: Similar to information board tasks, Mouselab is a computerised paradigm where information about choice options is hidden behind boxes on a screen. Participants access information by moving their mouse cursor over the boxes, and the program records their search pattern and time spent on each piece of information. For instance, Lohse and Johnson (1996) used Mouselab to compare the information search patterns of expert and novice consumers when choosing among computers.
- Eye-tracking tasks: Eye-tracking technology is used to record participants' gaze patterns as they view information about choice options on a screen. This provides a more natural and continuous measure of information search compared to information board or Mouselab tasks. Russo and Rosen (1975) were among the first to use eye-tracking to study shoppers' DM processes when choosing between different brands of pasta.
- Verbal protocol tasks: Verbal protocol tasks, or "think-aloud protocols," are crucial for understanding cognitive processes in DM. This technique has roots in Herbert Simon's work and was further developed by Clayton Lewis (Wikipedia, 2023). Simon's concept of bounded rationality (1955) laid the foundation for methods revealing cognitive processes, including think-aloud protocols. Clayton Lewis refined and popularized this

method, particularly in human-computer interaction. His 1982 IBM report outlined procedures for conducting and analysing think-aloud studies, establishing it as a standard method for usability testing and interface design (Lewis, 1982). In these tasks, participants are asked to "think aloud" as they make a decision, verbalising their thoughts, feelings, and decision processes. The verbal reports are then analysed to identify the strategies and considerations involved in the decision. The protocol typically involves participants verbalising their thoughts during a task, recording these verbalisations, and analysing the transcripts to identify patterns and strategies. This method provides rich, qualitative data about cognitive processes, reveals step-by-step reasoning, and can uncover unexpected strategies (Lewis, 1982). For example, Bettman and Park (1980) used verbal protocols to study consumers' decision processes when choosing between different microwave ovens. However, limitations exist. The act of thinking aloud may alter the cognitive processes being studied, and some processes may not be accessible to verbal reporting. Despite these limitations, think-aloud protocols remain a valuable tool across various fields, including psychology, education, and user experience design.

- Retrospective report tasks: After making a decision, participants are asked to report on their decision process, including the information they considered, the strategies they used, and the reasons for their choice. While these reports may be subject to forgetting and biases, they can still provide valuable insights into decision processes. For instance, Slovic (1995) used retrospective reports to study the constructive nature of preferences in tasks like choosing among gambles or consumer products.
- Reaction time tasks: The time taken to make a decision is recorded and used as an indicator of the cognitive effort or difficulty involved. Choices made more quickly are assumed to involve simpler or more automatic processes, while slower choices are thought to reflect more deliberate or complex processing. Fazio (1990) used reaction time tasks to study the automaticity of attitudes and their influence on DM.

These tasks have been used in various domains, including consumer choice, risky DM, and multi-attribute choice. They have provided valuable insights into the cognitive processes underlying DM, such as the use of heuristics, the impact of task complexity, and the trade-offs between effort and accuracy. However, these tasks often involve simplified, artificial scenarios that may not fully capture the complexity and context of real-world DM.

2.4 THE ROLE OF EMOTIONS IN DECISION MAKING

While early DM research emphasised the role of cognitive processes (Axten et al., 1973), more recent work has highlighted the importance of emotions and affect in shaping decision outcomes (Slovic, 2004). Even seemingly deliberative decisions may be influenced not only by careful information processing but also by intuitive judgments of how a particular outcome feels (Lerner et al., 2015; Loewenstein & Lerner, 2003). This holds true even in situations where numeric information about the likelihood of certain events is available (O'Hagan et al., 2006; Slovic et al., 2000; Windschitl & Weber, 1999).

Research has shown that some trade-offs are more emotionally difficult than others, particularly when they involve attributes that are considered sacred or protected (Baron & Spranca, 1997). People tend to avoid making these emotionally challenging trade-offs, which in turn shapes their decision strategies (Baron & Spranca, 1997; Connolly & Hogarth, 1982).

Experimental studies have demonstrated that when faced with emotionally difficult decisions, people avoid compensatory evaluation and instead select the most attractive alternative on the dimension that is difficult to trade off (Luce et al., 1999, 2001). The emotional aspects of specific options can also influence decision strategies. For instance, people invoke different choice strategies when forced to choose the lesser of two evils, as revealed by Luce and colleagues' (2000) experiments. In their experiments on housing choice, they found that when faced with a set of substandard options, people are far more likely to engage in maximising behaviour and select the alternative with the best value on whatever is perceived as the dominant substandard feature. In other words, having a suboptimal choice set reduces the likelihood of trade-offs on multiple attributes. Extending this idea to a different sociological context, a woman confronted with a dating pool filled with individuals she perceives as arrogant partners may focus on selecting the group's least arrogant.

A substantial body of work on risk perception has shown that people's emotional responses play a key role in how they evaluate the risks and benefits of a given situation (Loewenstein et al., 2001; Slovic, 1987; Slovic et al., 2004; Slovic & Peters, 2006). Fischhoff and colleagues (1978) found that people's perceptions of risks decrease as perceived benefits increase, even though risks and benefits tend to be positively correlated. They also noted that the attribute most highly correlated with perceived risk is the extent to which the item in question evoked a feeling of dread, a finding that has been confirmed in many subsequent studies (McDaniels et al., 1997).

Further research has demonstrated that stronger negative emotional responses lead to perceptions of greater risks and lower benefits (Alhakami & Slovic, 1994; Slovic & Peters, 2006). This has given rise to the affect heuristic, which posits that people have positive and negative associations with different stimuli, and these associations influence their judgments. This shortcut is often more efficient and easier than cognitive strategies like weighing pros and cons or using disjunctive rules to evaluate choice outcomes (Slovic et al., 2004).

2.5 DUAL-PROCESS THEORIES: SYSTEM 1 AND SYSTEM 2 THINKING

The literature on cognitive processes in DM, as well as the relationship between affect and DM, has been greatly influenced by dual-process theories, which posit that human reasoning and DM involve two distinct systems or types of processing (Evans, 2008; Kahneman, 2011; Stanovich & West, 2000). These theories, summarised in Table 1, distinguish between an intuitive, automatic, and fast system ("System 1") and a deliberate, controlled, and slow system ("System 2"). The two systems differ in their properties, the tasks they are suited for, and the types of errors they are prone to. Dual-process theories have been used to explain various phenomena in DM, such as the use of heuristics and biases (Kahneman & Frederick, 2002), the construction of preferences (McDaniels et al., 1995), and the role of emotion in judgment (Loewenstein et al., 2001). The application of dual-process theories to DM has generated a rich body of research on the interplay between intuitive and deliberate processes in judgment and choice. For example, studies have shown that time pressure and cognitive load can lead to a greater reliance on System 1 processes, resulting in more heuristic-based and less accurate decisions (Finucane et al., 2000; Payne et al., 1993). Other research has examined how individual differences in cognitive ability and thinking styles relate to the use of System 1 and System 2 processes in DM (Frederick, 2005; Stanovich & West, 2000).

According to this notion, as hinted in the introduction, people experience the world in two different ways: one that is fast, intuitive, automatic, and unconscious, and another that is slow, analytical, deliberate, and verbal (Evans, 2008; Kahneman, 2011; Stanovich & West, 2000). The key differences in the properties of the two systems are listed in Table 1. According to Stanovich and West (2000), System 1 is characterised as automatic, largely unconscious, and relatively undemanding of computational capacity. Thus, it conjoins properties of automaticity and heuristic processing, as these constructs have been variously discussed in the literature. These properties characterise what Levinson (1995) has termed interactional intelligence.

System 2 conjoins the various characteristics that have been viewed as typifying controlled processing. It encompasses the processes of analytic intelligence that have traditionally been studied by information processing theorists trying to uncover the computational components underlying intelligence. Furthermore, Stanovich and West (2000) conjecture that errors in reasoning are associated with conflicts between intentional and associative reasoning.

Table 1

The terms for the two systems used by a variety of theorists and the properties of dual-process theories of reasoning[1]

	System 1	**System 2**
Dual-Process Theories:		
Sloman (1996)	associative system	rule-based system
Evans (1984, 1989)	heuristic processing	analytic processing
Evans & Over (1996)	tacit thought processes	explicit thought processes
Reber (1989)	implicit cognition	explicit learning
Levinson (1995)	interactional intelligence	analytic intelligence
Epstein (1994)	experiential system	rational system
Pollock (1989)	quick and inflexible modules	intellection
Hammond (1996)	intuitive cognition	analytical cognition
Klein (1999)	recognition-primed decisions	rational choice strategy
Johnson-Laird (1983)	implicit inferences	explicit inferences
Shiffrin & Schneider (1977)	automatic processing	controlled processing
Posner & Snyder (1975)	automatic activation	conscious processing system
Properties:	associative	rule-based
	holistic	analytic
	automatic	controlled
	relatively undemanding of cognitive capacity	demanding of cognitive capacity
	relatively fast	relatively slow

[1] Adapted from Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate?. *Behavioral and brain sciences*, *23*(5), 645-665.

	acquisition by biology, exposure, and personal experience	acquisition by cultural and formal tuition
Task Construal:	highly contextualised personalised conversational and socialised	decontextualised depersonalised asocial
Type of Intelligence:	interactional	analytic (psychometric IQ)

Researchers have used various methods and tasks to study the properties and interplay of System 1 and System 2 processes in DM. These tasks are designed to manipulate factors like time pressure, cognitive load, and the availability of information to examine how these factors influence the relative contributions of intuitive and deliberate processes. Below are some examples:

- Cognitive Reflection Test: Developed by Frederick (2005), the CRT is a set of simple problems that have intuitive but incorrect answers, as well as correct answers that require deliberate reasoning. For example, "A bat and a ball cost $1.10. The bat costs $1.00 more than the ball. How much does the ball cost?" The intuitive answer is 10 cents, but the correct answer is 5 cents. Performance on the CRT is thought to reflect the ability to override System 1 intuitions and engage in System 2 thinking.
- Syllogistic reasoning tasks: Syllogisms are logical arguments that consist of two premises and a conclusion. Some syllogisms are valid (the conclusion follows logically from the premises), while others are invalid. Researchers have used syllogistic reasoning tasks to study the interplay between System 1 and System 2 processes, as these tasks can generate conflicts between intuitive beliefs and logical reasoning (Evans, 2003).
- Base-rate neglect problems: These tasks present participants with a description of an individual and a set of base rates for different categories (e.g., the proportion of engineers and lawyers in a sample). Participants are asked to judge the probability that the individual belongs to each category. System 1 processes tend to rely on the representativeness of the description, leading to base-rate neglect, while System 2 processes are more likely to integrate the base-rate (Tversky & Kahneman, 1973).

- Framing effects: Researchers have used framing tasks to study how the presentation of information influences DM. For example, in the "Asian disease problem" (Tversky & Kahneman, 1981), participants are more likely to choose a certain option when the outcomes are framed as gains (lives saved) and a risky option when the outcomes are framed as losses (lives lost). Framing effects are thought to arise from System 1 processes, while System 2 processes are more likely to recognise the equivalence of the options.
- Time pressure and cognitive load manipulations: Researchers have manipulated time pressure and cognitive load to examine their effects on System 1 and System 2 processing. For example, Finucane and colleagues (2000) found that time pressure increased the influence of affect on judgments of risk and benefit, suggesting a greater reliance on System 1 processes. Similarly, Shiv (1999) found that cognitive load increased the choice of an affectively attractive but less optimal option, indicating a shift towards System 1 processing.
- Implicit Association Test (IAT): The IAT (Greenwald et al., 1998) is a reaction-time task that measures the strength of automatic associations between concepts. Participants are asked to categorise stimuli into different categories (e.g., positive vs. negative words, male vs. female names) as quickly as possible. The IAT is thought to capture implicit attitudes and stereotypes that arise from System 1 processes, while explicit measures (e.g., self-report questionnaires) are more likely to reflect System 2 processes.

These tasks and methods have been used to provide evidence for the distinct properties and influences of System 1 and System 2 processes in DM. By manipulating factors like time pressure, cognitive load, and the availability of information, researchers can examine how these factors shift the balance between intuitive and deliberate processing and influence judgment and choice outcomes. The findings from these studies have contributed to the development and refinement of dual-process theories and their application to various domains of DM. Although some scholars debate whether automatic and deliberative processes should be considered as polar extremes or rather as a smooth continuum (Leschziner & Green, 2013), the dual-process *model* remains a useful framework for behavioural decision research. Because of its pedagogic simplicity, it has become very popular to the point that for students, it seems almost reified, as if there were two different neural pathways.

Dual-process theories offer a more nuanced view of DM than rational choice models, accounting for both intuitive and deliberative cognitive processes. This approach provides a compelling explanation for many DM phenomena, including cognitive biases and the influence of emotions on judgment. However, the dichotomous nature of these theories may oversimplify the complexity of cognitive processes. Critics argue that the distinction between System 1 and System 2 thinking may be more of a continuum than a strict dichotomy. Furthermore, these theories often rely on controlled laboratory tasks, which may not fully capture the dynamic interplay between intuitive and deliberative processes in naturalistic settings. Despite these limitations, dual-process theories have significantly advanced our understanding of the cognitive mechanisms underlying DM.

As we delve further into the cognitive mechanisms underpinning DM, it becomes evident that these processes are not isolated within the mind but are influenced by our physical interactions with the world. This leads us to the next section, where we explore how situated and embodied cognition expands our understanding of DM beyond internal mental processes to include the body's interactions with its environment.

2.6 SITUATED AND EMBODIED COGNITION: EXPANDING THE DM CONTEXT

While NDM approaches have significantly advanced our understanding of real-world decision processes, they primarily focus on how individuals use their experience and knowledge to make decisions in complex, dynamic environments. However, recent developments in cognitive science suggest that to fully comprehend DM, especially in everyday contexts, we must consider not only the decision-maker's internal processes but also their physical and social environment. This shift in perspective has given rise to theories of situated and embodied cognition, which propose that cognitive processes, including DM, are fundamentally grounded in the body's interactions with its environment. These approaches offer new insights into how micro-decisions in everyday life might be shaped by factors beyond just mental deliberation, considering the role of physical experiences, environmental cues, and social contexts. The following section explores these theories and their implications for understanding the intricate nature of everyday DM.

Hollan et al. (2000) and Hutchins (1995) propose that cognitive processes are not confined to individual minds but are distributed across people, their environment, and the artefacts they use. This distributed cognition approach suggests that DM is not solely an internal mental operation but involves interactions with the external world. Hollan and Stornetta (1992) further explore how technology and environmental factors are integral to cognitive processes, including DM. Their work implies that the tools and technologies we use do not merely aid cognition but are part of the cognitive system itself, a perspective particularly relevant to understanding MDM in everyday contexts.

The situation of the actor in the environment is of course perceived through the senses. Basso and Oullier’s work on embodied cognition principles (2010) argues that bodily states, sensations, on top of interactions with the environment, significantly influence our DM processes. This view challenges traditional cognitive approaches to consumer behaviour, emphasising that decisions are not purely mental processes but are deeply influenced by bodily states and environmental factors. Basso's recent work on embodied economics (2024) presents a radical shift in economic thinking that has significant implications for understanding DM processes, including micro-decisions in everyday life. His approach challenges the disembodied, abstract models that have dominated economic theory and instead proposes a foundational alternative rooted in embodied cognition. Basso argues that the 20th century witnessed a progressive disembodiment of economic models through increased mathematisation and formal abstraction. Even proponents of embodied cognition, such as Hayek, paradoxically championed abstract market order as a disembodied superhuman intelligence. In contrast, embodied economics reintegrates the body, environment, and social context into our understanding of economic behaviour and DM. This perspective aligns closely with the focus of this thesis on MDM in everyday contexts, as we will examine how the decision process is *experienced and performed* rather than attempting to describe it by logical reasoning. By emphasising the role of embodiment in economic behaviour, Basso's work provides a theoretical framework for understanding how physical experiences, environmental cues, and social interactions shape our daily choices. It suggests that to fully comprehend micro-decisions, we must consider not just mental processes but also how our bodies and environments influence our choices.

The perspectives of Basso's work on embodied economics, as well as Hutchin’s and Hollan's distributed cognition approach, and more generally, the notions of situated and embodied cognition suggest that micro-decisions are not isolated mental events but are deeply embedded in our physical social, and economic environments as they couple with our bodily interpretive system. This underscores the importance of studying DM in real-world contexts, as this thesis aims to do, to capture the full complexity of how people navigate their daily choices.

Moving forward, we will examine how NDM research has further advanced our understanding by studying real-world decision processes. This research emphasises the role of expertise, time pressure, and high stakes in shaping decisions. More recent NDM research has sought to study decision processes in more naturalistic settings using methods like field experiments and experience sampling.

2.7 NATURALISTIC DECISION-MAKING: STUDYING REAL-WORLD CHOICES

Incorporating realistic context into judgment and choice tasks gained prominence in the 1990s with the work of Slovic, Lichtenstein, and colleagues on risk perception (1977). Using domain-specific scenarios and field surveys, they demonstrated the multidimensional nature of risk attitudes and the importance of affect in risk judgments. Using interviews and case analyses, NDM research also emphasised the role of expertise, time pressure, and high stakes in real-world decision processes (Klein, 1999).

NDM emerged as a distinct field of research in the late 1980s and early 1990s in response to the limitations of traditional DM research in capturing the complexity and challenges of real-world decision contexts. The origins of NDM can be traced back to a series of studies and events that highlighted the need for a new approach to understanding DM in naturalistic settings:

- Recognition-Primed Decision (RPD) Model: In the 1980s, Gary Klein and his colleagues conducted a series of studies using the critical decision method on the DM of firefighters, nurses, and military commanders (Klein et al., 1989). These studies revealed that experts often made rapid, intuitive decisions based on their experience and recognition of patterns in the environment rather than through a deliberate analysis of options. This led to the development of the RPD model (Klein, 1993), which became a foundational framework for NDM research.
- Limitations of classical DM Research: Traditional DM research, based on normative models and laboratory experiments, was criticised for its focus on simplified, abstract tasks that failed to capture the complexity and dynamics of real-world DM (Lipshitz, 1993). NDM researchers argued that classical DM approaches were inadequate for understanding how people make decisions under time pressure, uncertainty, and high stakes and called for a new paradigm that emphasised the study of DM in naturalistic contexts (Orasanu & Connolly, 1993).
- Applied and Multidisciplinary Focus: NDM research was driven by a strong applied and multidisciplinary focus, with researchers seeking to understand and improve DM

in various domains, including aviation, healthcare, military, law enforcement, and emergency response (Drillings et al., 1997). This applied focus was motivated by a desire to develop interventions and support systems to help people make better decisions in challenging real-world situations.

- Emphasis on Expertise and Adaptive DM: NDM research emphasised the importance of studying expert DM and understanding how they adapt to complex and dynamic environments (Klein, 1998). This focus on expertise and adaptation was in contrast to traditional DM research, which often studied novice or student populations in static, simplified tasks. NDM researchers argued that the study of expert DM could provide valuable insights into the strategies and skills required for effective performance in naturalistic settings.

The emergence of NDM as a distinct field of research was driven by recognising the limitations of traditional DM research in capturing the complexity and challenges of real-world decision contexts. NDM researchers sought to develop new methods and frameworks for studying DM in naturalistic settings, focusing on expertise, adaptation, and application. While NDM has made significant contributions to our understanding of DM in various domains, it has also faced challenges in terms of generalisability, integration with other approaches, and the development of predictive models (Lipshitz et al., 2001). As the field continues to evolve, NDM research is needed to address these challenges and develop more comprehensive and rigorous theories of DM in naturalistic contexts.

The 1980s and 1990s also saw a growing interest in individual differences in DM, with researchers examining the role of cognitive abilities (Stanovich & West, 1998), DM styles (S. G. Scott & Bruce, 1995), and personality traits (Lauriola & Levin, 2001) in shaping choice processes. For example, Cacioppo and Petty's (1986) Elaboration Likelihood Model posited that people vary in their motivation and ability to engage in effortful cognitive processing, influencing their susceptibility to situational factors like message framing and source credibility. Stanovich and West (2000) found substantial variability in performance on reasoning tasks that could not be explained solely by cognitive ability. Later work by Dewberry et al. (2013) showed that DM styles and personality traits predicted real-world decision outcomes over and above cognitive styles. Research on age-related changes in DM (Mata et al., 2011) and the influence of culture (Weber & Morris, 2010) has further highlighted the importance of considering individual and group differences. However, the importance of situational factors was reaffirmed by the rise of behavioural economics in the 1990s and 2000s.

Thaler and Sunstein's (2008) work on choice architecture showed how subtle changes in the presentation of options can have significant effects on people's choices, even when their underlying preferences remain stable. Similarly, research on social norms (Cialdini et al., 1990), default options (Johnson & Goldstein, 2003), and contextual primes (Kay et al., 2004) demonstrated the power of situational influence in shaping behaviour.

Appelt et al. (2011) proposed a Person-by-Situation framework, arguing that individual differences in cognitive abilities, motivation, and experience moderate the impact of situational factors on choice. For example, Figner and Weber (2011) found that individual differences in risk attitudes and cognitive reflection moderate the framing effect in risky choice. Similarly, research on the "decision-making competence" construct (De Bruin et al., 2007) has shown that people vary in their ability to resist situational biases and make consistent, well-reasoned choices.

Moreover, the development of new methodological approaches, such as experience sampling (Csikszentmihalyi & Larson, 1987a), mobile sensing (Harari et al., 2016a), and virtual reality (Diemer et al., 2015), has enabled researchers to study DM in more naturalistic contexts, capturing the interplay of personal and situational factors in real-world choice processes. For example, a study by Srivastava et al. (2009) used experience sampling to demonstrate how situational factors like social context and momentary affect moderate the impact of personality traits on risk-taking behaviour.

NDM addresses many limitations of earlier approaches by studying DM in real-world contexts. Its strength lies in its ecological validity and focus on expert decision-makers in high-stakes environments. NDM has provided valuable insights into how people make decisions under uncertainty, time pressure, and dynamic conditions. However, the approach faces challenges in terms of generalisability. Its focus on expert decision-makers in specific domains may limit its applicability to everyday DM by non-experts. Additionally, the descriptive nature of NDM research can make it difficult to develop predictive models. Despite these challenges, NDM has significantly broadened our understanding of DM processes in complex, real-world environments.

2.8 BEHAVIOURAL AND EXPERIMENTAL ECONOMICS: CHOICE ARCHITECTURE AND SITUATIONAL INFLUENCE

Concerns about the validity of findings from hypothetical scenarios led to a rise in field experiments and real-choice paradigms in the 2000s. Experimental economics, which emerged in the 1960s and gained prominence in the 1980s and 1990s, has also made significant contributions to the study of DM by using controlled laboratory experiments with real monetary incentives. Seminal work in this field includes Vernon Smith's (1962) study on competitive market behaviour, which laid the foundation for the use of experimental methods in economics. Kahneman, Knetsch, and Thaler's (1990) work on the endowment effect and loss aversion demonstrated how experimental findings can challenge standard economic assumptions. Fehr and Schmidt's (1999) research on fairness and reciprocity in economic interactions highlighted the importance of social preferences in DM. Additionally, the work of Camerer and Thaler (1995) on ultimatum and dictator games revealed the role of fairness considerations in bargaining and resource allocation. These experimental studies have provided valuable insights into the psychological factors influencing economic DM and have contributed to the development of behavioural economics as a field.

In recent years, experimental economists have continued to make important contributions to the study of DM. For example, Ariely, Loewenstein, and Prelec (2003) demonstrated the role of coherent arbitrariness in shaping preferences, showing how initial, seemingly arbitrary anchors can have a lasting impact on individuals' willingness to pay for goods. Falk and Heckman (2009) provided a comprehensive overview of the advantages and limitations of laboratory experiments in economics, highlighting their value for testing economic theories and studying social preferences. Charness and Gneezy (2012) reviewed the use of incentives in economic experiments, discussing the importance of properly designing incentive schemes to ensure the validity and reliability of experimental results. Furthermore, the work of Andreoni and Sprenger (2012) on risk and time preferences has advanced our understanding of how individuals make intertemporal choices and how these preferences can be elicited using experimental methods.

Moreover, web-based studies on financial, medical, and policy decisions enabled the use of large, diverse samples and interactive, realistic choice environments (Goldstein et al., 2008; Mullainathan, 2013). For example, Birnbaum (2011) used online surveys to test descriptive models of risky choice, while Weber et al. (2007) employed web-based process tracing to study consumer decisions. Behavioural economists also demonstrated the impact of choice architecture interventions like defaults (Johnson & Goldstein, 2003), ordering effects (Levav et al., 2010), and social influence (Nolan et al., 2008) in natural field experiments.

Recent methodological advances leverage digital traces, video recordings, and virtual reality to capture natural decision processes with high fidelity. Online activity and mobile sensor data have been used to extract multistage decision rules and context effects in domains like dating (Bruch et al., 2016) and financial choice (Matz et al., 2017), while video analysis has illuminated the role of embodied cues like gestures in everyday problem-solving (Goldin-Meadow & Cook, 2012). Schulte-Mecklenbeck et al. (2017a) reviewed the use of psychophysiological methods like pupillometry, facial coding, and EEG to measure emotional responses during DM. Educational video games and simulations offer promise as tools for assessing and improving decision skills in domains like medical diagnosis (Manek et al., 2017) and triage (Elgin et al., 2021).

2.9 MICRO DECISION-MAKING: THE CUMULATIVE IMPACT OF SMALL CHOICES IN EVERYDAY LIFE

Building on the above developments, a growing body of research has focused on studying MDM. MDM refers to the numerous, small-scale decisions individuals make daily, often without much deliberation or conscious thought. While seemingly trivial in isolation, these decisions can have significant cumulative effects on personal and societal outcomes. The study of MDM has gained attention in recent years, with researchers using various methods to capture and analyse the processes underlying these everyday choices.

Researchers have used experience sampling methods and daily diary studies to capture MDM in real time and in natural contexts, for example, Hofmann et al. (2012) used experience sampling methods to study the role of self-control in everyday desires and choices, finding that people experience desires frequently throughout the day and often try to resist them. Similarly, Milyavskaya et al. (2015) used a daily diary approach to examine the effects of goal pursuit on well-being, showing that the pursuit of authentic goals was associated with greater self-determination and positive affect. Additionally, some researchers have used observational methods and video recordings to study MDM in specific domains, such as consumer behaviour and parent-child interactions. For example, Hui et al. (2009) used video recordings to analyse consumers' in-store shopping behaviour, identifying patterns of product examination, comparison, and selection. Finally, with the advent of smartphones and wearable devices, researchers have begun to use ecological momentary assessment and mobile sensing methods to study MDM in real-time and in natural contexts. For example, Krpan et al. (2019) used ecological momentary assessment to study the role of emotions in snack choice, finding that positive affect was associated with healthier snack choices. Similarly, Lathia et al. (2017) used mobile sensing data to predict individual differences in physical activity and sleep patterns, highlighting the potential of these methods for capturing the behavioural correlates of MDM.

In understanding MDM, it's crucial to consider the multi-faceted nature of cognition, as proposed by Madsen in his work on multi-scalar temporal cognition (2017). Madsen argues that cognitive function cannot be understood solely through internal mechanisms but must also account for externally distributed interactions and multi-scalar temporal elements. This perspective is particularly relevant to MDM in everyday contexts. It suggests that our moment-to-moment decisions are not isolated cognitive events but are shaped by a complex interplay of internal processes (such as neural connections), external factors (like environmental cues and social interactions), and temporal elements spanning from immediate circumstances to long-term socio-cultural influences. While the situated nature of DM highlights the current setting and internal states, it is obvious that micro-decisions are set in the larger perspective of goal-directed action within a motivated activity. This brings in the necessity of considering future states (the goal), and of course, the current competencies and state of the subject are built upon an experience that took place in the past. Madsen's emphasis on the functional nature of cognition implies that micro-decisions, while responding to objective reality, are fundamentally constructed and emergent phenomena. This view aligns with our observations of MDM as a dynamic, context-dependent process. Furthermore, Madsen's suggestion of using Agent-Based Models to test such complex cognitive theories offers a potential avenue for future research in modelling the intricate processes underlying MDM in real-world scenarios.

Figures 1 and 2 provide a schematic overview of the most relevant literature we reviewed, while the next sections review two other theories we have used in our research as frameworks for activity analyses: Activity Theory and Installation Theory. The Figures categorise decision processes into cognitive, emotional, and contextual factors that shape them, followed by some relevant key factors that have been studied to understand DM in everyday life.

Figure 2 *The role of different factors (cognitive, emotional, and contextual) in decision processes*

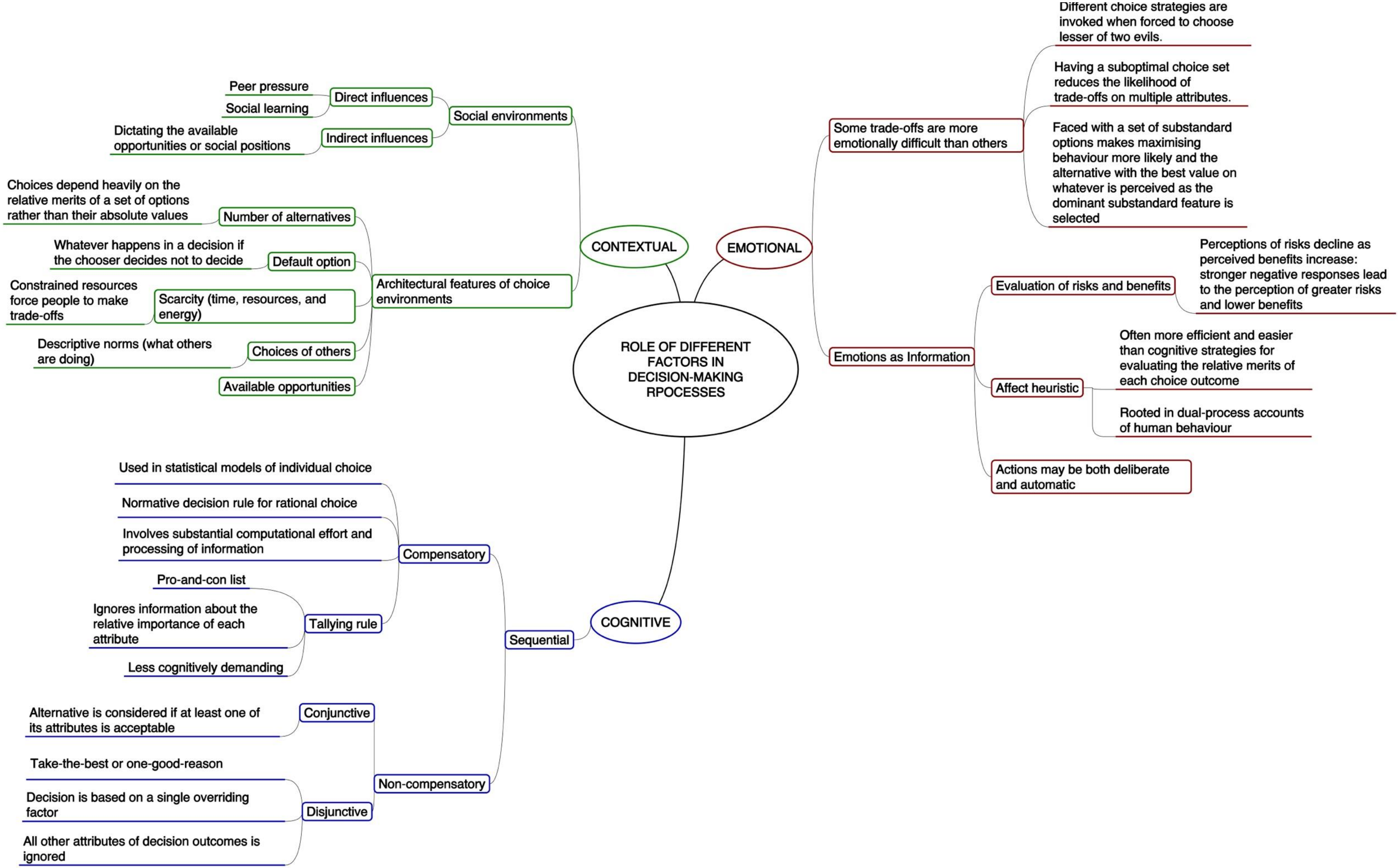
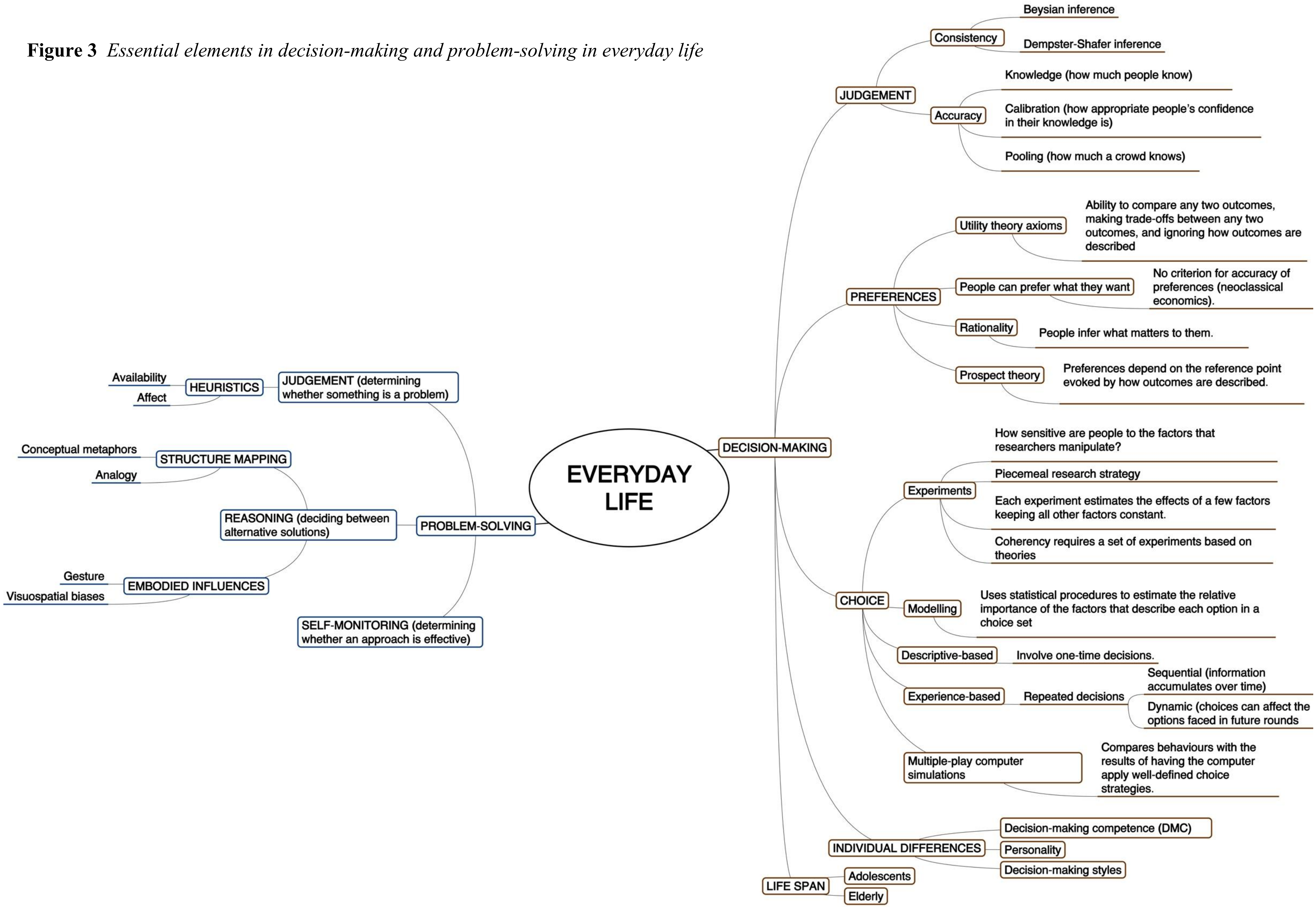


Figure 3 *Essential elements in decision-making and problem-solving in everyday life*



2.10 ACTIVITY THEORY

The method used in this research (see Research Design) investigates first-person recordings of activity in a natural context, focusing on moments of decision and elucidating the mental processes that took place at that moment in their specific context. Previous work with similar empirical material (Fauquet-Alekhine, 2017; Lahlou, 2018; Lahlou et al., 2015; Le Bellu et al., 2016; Nosulenko & Samoylenko, 2009) has shown that (Russian) activity theory is an efficient approach to framing the analysis and facilitating the elicitation of the mental processes by the subject of action (the actor). Indeed, to fully understand decisions, it is required to know the individual and collective goals pursued by decision-makers. What are their motives? Is there an adequate relationship between these goals and the final result? Knowing their goals and motives will enable us to understand their rationale process. Activity Theory enables real human activity to be analysed and structured.

Activity Theory, initially developed by Sergei Rubinstein and Alexei Leontiev in the 1930s, is a fundamental domain in Soviet psychology (Leontiev, 1978; Rubinshtein, 1946). More recently, it spread to France through the work of Yves Clot (2009) and to Scandinavia via Yrjö Engeström's (1987, 2000) contributions. The literature on Activity Theory spans tens of thousands of papers, most of them in Russian and not translated. There are many shades of Activity Theory (see Lahlou et al., 2012; Le Bellu et al., 2016; Nosulenko et al., 2005; Rabardel & Beguin, 2005 for history). We will use here a simplified version described by Lahlou below that was developed for operational purposes by a team that also used SEBE (Everri et al., 2020; Lahlou, 2006, 2011, 2022; Lahlou et al., 2015; Le Bellu et al., 2010, 2016).

In a nutshell, activity theory considers activity as an oriented trajectory from a given state ("conditions given") to a consciously represented expected final state ("goal"), driven by internal motives (urge to reach some internal state of balance or satisfaction). Activity is subject-centric: performed from the perspective of the subject. The trajectory of activity is a succession of small problems to be solved ("tasks"), which can each be seen as reaching a local subgoal." (Lahlou, 2011) Therefore, at each step, a task may present itself as a problem for DM, typically a choice between different possible behaviours. Using activity theory provided the analysis with information about participants' goals and subgoals and how they construct and solve the problems they face in real-life situations. Therefore, the output of such analysis provided evidence-based and relevant ground for discussion with the participants themselves.

2.11 INSTALLATION THEORY

The research by Lahlou and colleagues (Lahlou, 2018) studied human behaviour in diverse natural settings, from mundane ones such as cooking or changing a flat tyre to professional activity in hospitals, police and nuclear plants. According to Installation Theory (Lahlou, 2018, 2024), Behaviour in society is shaped by three combined factors: what is physically possible to do (affordances of the environment), what people are able to do (embodied competencies), and what is expected or allowed (social regulation). This is precisely because behaviour in society must be predictable.

The subject is guided at every step of their behaviour by these "installations", in the way that when you travel by plane, at the airport, the steps you take from the moment you check in to the moment you take your seat in the plane are fixed and predictable. Installations possess a momentum of their own. Rather than being a matter of free will, these channelled trajectories are oriented at every step by MDM that is framed by the installation. In such a state, decisions are not made through entirely individual processes. Rather, they result from a distributed process where *society* has framed the situation and guides individual choices along a limited range of possibilities. Lahlou, calls this the "scarcity of free will" (2024, p. 43-44): he argues that individuals exert their free will rather for the goals than for the micro-decisions, which are not deliberative nor unconscious but made in a semi-automatic "channelled state", where the local steps are accepted as means to reach the goal, as something that you just have to do, "the way things are done around here". Lahlou further explains: "When I pass a test, when I board a train, when I queue for my bowl of soup, when I undress for the shower, I behave in installations; sometimes I follow my own will, sometimes I don't. Most of the time, my freedom addresses only some aspects of the process" (Lahlou, 2018).

Installation theory considers these channelling "installations" to be constituted of three layers that combine the external and internal setting of the situation: the material environment (objects and their physical affordances), embodied competencies (reflexes, skills, knowledge, representations, mental models, experience, habitus, common sense and so forth), and social regulation (appropriate behaviour). Each layer results from previous experience and societal design, and each contributes to the determination of behaviour; nevertheless, each layer alone leaves considerable degrees of freedom and, therefore, is an incomplete explanation of behaviour. However, when the layers operate simultaneously because the degrees of freedom they leave is not in the same direction, their combination leaves only a small tunnel of possibilities for the subject. This results in predictable behaviour. The predictability of behaviour is indispensable for complex societies, where most actions are distributed, and cooperation is necessary. That is why most behaviour, especially in public places, is channelled by installations to ensure the indispensable predictability of life in society, (Lahlou, 2024). Installations, according to Lahlou, are part of the "golden cage" societal contract, as they simultaneously constrain and empower us; so that, if we behave as expected, they enable us to enjoy the benefits of cooperation with the larger system and the sophisticated built social environment it has constructed over time ("if you do this, you get that"). So, installation theory insists on the combination of individual propensities of the subject (which are partly constructed by education) and of the socially constructed setting, hereby suggesting the view of a *distributed determination of behaviour* (and likely MDM) over the individual and the environment.

To conclude our review, this section has traced the historical development of DM research, from its origins in rational choice theory to the emergence of naturalistic and dual-process approaches that seek to capture the complexity of real-world choice contexts.

Early studies using simple gambles and abstract tasks revealed systematic deviations from normative principles and highlighted the bounded rationality of human DM. The heuristics and biases program, led by Tversky and Kahneman, further demonstrated the pervasive influence of cognitive shortcuts and situational factors on judgment and choice.

As the field progressed, researchers began to examine the cognitive processes underlying DM using process-tracing methods like think-aloud protocols, information boards, and eye-tracking. These studies provided evidence for contingent decision strategies, constructive preferences, and effort-accuracy trade-offs, challenging the assumption of stable and context-independent preferences. In parallel, the role of emotions in DM gained prominence, with researchers demonstrating the influence of affect, mood, and anticipatory emotions on judgment and choice.

The development of NDM approaches in the 1980s and 1990s shifted the focus towards studying DM in real-world contexts, emphasising the role of expertise, time pressure, and high stakes. NDM methods, such as the Critical Decision Method and the RPD Model, sought to capture the contextual factors and adaptive strategies that shape DM in domains like firefighting, military command, and nursing. The field has witnessed a growing integration of individual differences and situational factors in DM research in recent years. Dual-process theories, which distinguish between intuitive (System 1) and deliberate (System 2) modes of processing, have provided a framework for understanding the interplay of cognitive and situational factors in judgment and choice. Researchers have used various methods, such as cognitive reflection tests, syllogistic reasoning tasks, and time pressure manipulations, to study the properties and influences of the two systems.

Moreover, new methodological approaches, such as web-based experiments, mobile sensing, and virtual reality, have enabled researchers to study DM in more naturalistic and interactive contexts. These methods have shed light on the role of social influence, choice architecture, and embodied cognition in shaping decision processes. The application of DM research to societal issues like health, sustainability, and public policy has further underscored the importance of understanding choice processes in real-world settings.

3 RESEARCH GAP AND THE RESEARCH ANGLE

The field of DM research has made significant strides in understanding the cognitive, affective, and contextual factors that shape human choice processes. However, despite the proliferation of theoretical frameworks and methodological approaches, important gaps remain in our understanding of how people make decisions in everyday life.

One key limitation of traditional DM research is its heavy reliance on laboratory studies and artificial choice tasks. While these methods have yielded valuable insights into the heuristics, biases, and strategies that people use when making decisions, they often lack the ecological validity needed to capture the complexity and richness of real-world choice contexts (Fischhoff & Broomell, 2020; Klein, 2015). Many of the tasks used in these studies, such as monetary gambles and hypothetical scenarios, bear little resemblance to the types of decisions that people face in their daily lives, which are often characterised by time pressure, incomplete information, and competing demands (Lipshitz et al., 2001).

Moreover, traditional DM research has tended to focus on one-off, isolated choices, neglecting the fact that many of the decisions people make in everyday life are part of ongoing, dynamic processes (Schraagen et al., 2008). The study of MDM has begun to address this gap by examining the numerous small-scale decisions individuals make in their daily lives (Hofmann et al., 2012; Milyavskaya et al., 2015). However, much of this research relies on retrospective self-reports or momentary assessments, which may not fully capture the subjective experience and micro-processes underlying these choices.

Another limitation of existing DM research is its emphasis on nomothetic, group-level analyses, which can obscure important individual differences in choice processes (Loewenstein et al., 2001). While some studies have examined the role of personality traits, cognitive abilities, and DM styles in shaping choice outcomes (Appelt et al., 2011; De Bruin et al., 2007), there is a need for more idiographic, person-centred approaches that capture the unique ways in which individuals navigate decision situations in their daily lives.

Furthermore, despite the growing recognition of the importance of naturalistic and ecologically valid methods in DM research (Drillings et al., 1997; Klein, 2008), there remains a paucity of studies that examine decision processes in situ as they unfold in real-life contexts. While methods such as experience sampling, mobile sensing, and video-based observation have begun to address this gap (Hui et al., 2009; Krpan et al., 2019), there is a need for more immersive, first-person approaches that capture the subjective experience and situated nature of everyday DM.

The field of DM research has also been criticised for its fragmentation and lack of integration across different theoretical perspectives and methodological approaches (Weiss & Shanteau, 2021). While dual-process theories have provided a useful framework for understanding the interplay of intuitive and deliberate processes in DM (Kahneman, 2011; Stanovich & West, 2000), there is a need for more integrative models that incorporate insights from naturalistic, affective, and embodied approaches to DM (Lerner et al., 2015; Schraagen et al., 2008).

One way of viewing decision science limitations is in light of the data. Data limitations have hampered psychologists and sociologists' ability to study decision processes (Bruch & Feinberg, 2017).They have hampered the study of DM in naturalistic settings, which is one reason behind the development of the literature on lab experiments and formal models.

This limitation can be addressed by providing recordings of individuals' everyday lives in which decisions are captured with regard to their ecology as they experience, represent, and negotiate with others. This is what we attempted to do through this research. An expected impact is that it will advance applied psychology in the sense of having theories that are more fit for societal impact. An emerging theme in DM research is that science and society make progress together through two bridging activities, which Baddeley (1979) called "applied basic psychology" (seeing how theories fare in real-world settings) and "basic applied psychology" (domesticating phenomena observed in those settings for basic research). Due to such engagements, a second emerging theme is that the field has increased the heterogeneity of its tasks, methods, theories, and participants (Bruch & Feinberg, 2017). There is renewed interest in theories that can explain human action (Gross, 2009; Kroneberg, 2014) in psychology and other social sciences. Typically, what we do in this research is diversify the methods by providing real-time empirical evidence while observing human DM in everyday life.

The aim was to first apply basic psychology by evaluating how DM theories and diverse classifications fit in real-world behaviour, then domesticate the observed phenomena for further experimentation and eventually standardisation. This involves capturing the subjective experience of DM in everyday life to investigate the extent to which research findings hold true for natural decision behaviour.

Further investigations of the captured decisions can result in greater insight into human behaviour and action, which will allow for greater insights into the dynamic relationship between micro- and meso-level processes and their larger-scale implications (Hedström & Bearman, 2009).

Previous research primarily identified optimal ways of making decisions (defined as choices among alternatives) in well-structured settings that could be carefully controlled with limited emphasis on features of DM that are socially determined. To what extent DM in real-world everyday contexts is aligned with the diverse theories in the field remains largely overlooked. Furthermore, according to Bruch (2017), the DM literature has minimised the role of social context in decision processes. **This is deliberate.** Most experiments performed by psychologists are designed to isolate processes that can relate to features of decision tasks or brain functioning; it is incumbent on researchers working in this tradition to "desocialise" the environment and reduce it to a single aspect or a theoretically predicted confluence of factors. An illustrative example can be found in the research on heuristics. Although there is a rich body of work on how they are matched to particular decision environments (Gigerenzer & Gaissmaier, 2011), these environments are often pre-designed laboratory constructs aimed to control key features of the environment. This line of work intentionally eliminates aspects of realistic social environments, which limits its relevance for social sciences.

Decision science interventions seek to empower people to make sound, independent choices and to provide protections when that proves impossible. According to Lades et al. (2018), these interventions can be evaluated in two ways: whether they lead to people making better choices, and whether they lead to people having better DM processes, which better choices should follow. Our research findings, because they are grounded in naturalistic empirical evidence, may provide useful insight for identifying opportunities for interventions and their design and implementation. Our approach to capturing subjective experience may appear similar to previous research that measures experiential utility in everyday life (Kahneman et al., 2004). However, in addition to how people feel, this approach can also capture what people want (i.e., their "wantability" (Fisher, 1918)) in everyday life. Such direct collection of subjects' intentions in DM could complement indirect approaches that rely on choice data to reveal preferences. If the satisfaction of short-term desires is taken as the guide to welfare, a policy that gives people what they want at any given moment would be preferred over a policy that restricts choice. Similarly, different desires could be ranked according to their normative weight in the sense of a hierarchy of needs, for example, as suggested by Maslow (1958) and discussed in Witt (2017).

Because the problem is gigantic and multifactorial, this research limits the scope of its investigation to micro-decisions, of which the outcomes are easily observable and the context rather clear. How far such micro-decisions, such as those involved in cooking, cleaning, or daily work activities, involve vast and complex constructs such as values, culture, or world-views is unknown, and we have no pre-conception on the processes at work. We commenced our research with an exploratory, open-ended, observation-based approach, deliberately postponing the development of theoretical frameworks to ensure an unbiased and grounded understanding of the phenomenon. While this open approach implied a considerable toll on data collection, and heavy methodological developments, it turns out it enables thinking outside of the box of previous theoretical frameworks and yields novel findings.

Thus, to summarise, with regard to the identified gaps in the existing literature, this research attempts to explore how MDM is experienced and represented by individuals as they engage in their typical daily activities. By combining first-person video recordings, self-confrontation interviews, and detailed activity analysis with SEBE, we can capture the moment-to-moment dynamics, contextual factors, and subjective processes that shape everyday DM (Lahlou, 2011; Le Bellu et al., 2010; Oraee et al., 2024). This method allows for a fine-grained, idiographic analysis of how individuals navigate the myriad choices and challenges they face in their daily lives, providing a rich, contextualised understanding of DM in situ. By focusing on the subjective experience of decision-makers, SEBE addresses the need for more phenomenologically grounded approaches that capture the first-person perspective and lived experience of individuals (Varela & Shear, 2001).

As a collateral effect, it improves current methods and protocols by pointing out blind spots in previous investigations, as the research by Heitmayer and Lahlou using the same protocol did for the study of smartphone use (2021).

4 RESEARCH DESIGN

The study employs a mixed-method approach, primarily utilising the SEBE protocol to capture and analyse participants' first-person perspectives on their DM processes.

To ensure a well-informed and grounded main study, our research design incorporates an exploratory phase and pilot studies to refine the methodology, sampling criteria, coding protocol, and research validity. The exploratory phase aimed to identify key themes and activities representative of everyday DM, while the pilot studies tested and refined the research protocols, coding procedures, and concepts. Therefore, the development of the final protocol of our research was a culmination of insights, refinements, and lessons learned from the exploratory study and pilot studies.

4.1 STAGES OF RESEARCH: EXPLORATION, PILOT AND MAIN STUDY

The exploratory study provided a solid foundation for understanding the subjective experience of MDM in everyday life, revealing key themes, patterns, and representative activities. The pilot studies served as a crucial bridge, allowing us to test and refine the research methodology, particularly the innovative RRIW protocol (see the next section on Methodology), and to develop an initial activity model capturing MDM dynamics within the activity process context.

4.1.1 Exploratory Study

To ensure that we approach the complexities of DM with a fresh mindset, we started the research broadly to identify areas of interest to zoom in on. Initially, we sought to gain a preliminary understanding of MDM as it unfolds in natural contexts by collecting SEBE data. This involved recording participants during their typical daily activities and conducting RIWs.

We recorded 16 individuals, for a total of some 44 hours of first-person recordings, followed by 17 hours of (video-recorded) replay interviews (on 14 of the 16 participants). We thus obtained large datasets of participants' everyday lives and how they interpret them. Our method allowed us to capture real-time, situated experiences and delve into everyday activities to identify instances of DM and the factors influencing it. Ultimately, we obtained open-ended descriptions from participants that provided a rich tapestry of situations and activities, adding depth to our understanding.

Our initial analysis of these exploratory data (see Appendix E for the entire exploratory study) began by analysing rich textual data, which were descriptions of participants' subjective experiences as they engaged in their daily lives and went through typical everyday activities such as cleaning, cooking, organising and rearranging, grocery shopping, commuting, etc.

To analyse our data, we delved into the activity components and granularities to uncover areas for further investigation. We identified key themes and patterns in everyday DM through thematic analysis (TA) of the collected data. This analysis revealed recurrent themes such as *goals and motives*, *regulation of activities*, *evaluation and judgment*, *feedback acquisition*, and *efficiency*. These insights helped us uncover common challenges, strategies, and influential factors characterising everyday MDM. Additionally, by examining a range of activities in the SEBE data, we identified representative activities—cleaning, cooking, commuting, etc.—that are particularly relevant for understanding MDM in real-world contexts. Overall, we achieved the below objectives through our initial exploration of everyday activities:

1. We gained a preliminary understanding of the subjective experience of MDM in everyday life. Subcam footage was collected from participants engaging in their typical daily activities, capturing real-time, situated MDM experiences. RIWs were conducted to explore participants' subjective perspectives, reconstruct activities, and obtain rich contextualised verbatim from everyday MDM. These open-ended descriptions provided detailed accounts of various situations and activities in everyday life.
2. We identified key themes and patterns in everyday MDM. Thematic analysis was employed, revealing common challenges, strategies, and influential factors characterising MDM. This rich, data-driven foundation informed the main study's focus and design. It also informed our RIW topic guide and areas to focus on with the participants.
3. We identified representative activities for studying MDM in everyday life by examining the range of activities captured in the Subcam footage. The exploratory phase helped pinpoint activities involving frequent, diverse, and inconsequential micro-decisions, such as cleaning, cooking, and commuting, which served as focal points for the main study.
4. Insights from the exploratory phase guided the refinement of the research design and sampling criteria, ensuring the main study's ability to capture the complexity and diversity of MDM. The SEBE protocol was adjusted, the RIW structure modified, and the sampling criteria expanded to include a more diverse range of participants and activities.
5. The exploratory phase's data and insights informed the development of the innovative RRIW protocol (see Methodology). Open-ended descriptions of everyday MDM served as

a basis for developing a set of visual cues and terminology aligned with participants' experiences. During the RRIWs, participants could choose to code their activity themselves as they watched the recordings. Key micro-decision points, behavioural markers, and subjective experiences identified in the exploratory phase were incorporated into the RRIW protocol.

4.1.2 Pilot Study

Upon completion of the Exploratory Study, we then conducted a pilot study primarily to test and refine a new addition to our methodology (see next section on Methodology), which now included the RRIWs. Thus, the pilot studies conducted in this research served as a critical intermediary stage between the exploratory phase and the main study, aiming to achieve several key objectives. These objectives included testing and refining the RRIW protocol, validating the coding scheme and behavioural variables, assessing the technical feasibility of SEBE data collection and analysis, evaluating participant recruitment and sampling procedures, developing and refining a basic activity model, creating a template for presenting research findings and identifying potential improvements and refinements for the main study.

The RRIW improves the previous SEBE protocol, where participants review their recordings with the researcher and comment on it (Everri et al., 2020; Jonassen, 2016; Lahlou, 1999, 2011; Lahlou et al., 2015). This new protocol, the RRIW, facilitates the coding of the participants' activity *by the participants themselves* in the presence of the researcher. This addresses an important gap in previous studies, where coding was done by the researchers, with the possibility of biases or discrepancies between emic (subjective interpretation by the actor) and etic (scientific coding by the researcher) perspectives.

To test and refine the RRIW protocol, pilot RRIWs were conducted with a small sample of new participants, and discussions with other users of SEBE (researchers or participants) were conducted. After some informal tests to design the set-up, the pilot study included two new participants, who each coded about 30 minutes of their own data with the new protocol. All the process of coding was video-recorded and analysed with the help of participants. This allowed for the evaluation of the clarity of the new protocol instructions, the ease of use of the coding interface, and the overall participant experience. The pilot studies also sought to identify any potential challenges or limitations of the RRIW protocol, enabling necessary adjustments and improvements before implementation in the main study.

Furthermore, the pilot studies aimed to develop an initial theoretical framework for understanding MDM in real-world contexts by proposing a basic activity model based on the identified concepts and activity components. This model was refined through an iterative data collection and analysis process, incorporating insights from the exploratory phase, ultimately informing the final research design. The complete procedure for developing our final methodology can be found in the Appendices (see Exploratory study, and PILOT STUDIES Study).

4.1.3 Main Study

Building upon the insights and lessons learned from the pilot studies, the main study aimed to provide a more comprehensive and in-depth investigation of MDM in everyday life, employing the refined RRIW protocol, validated coding scheme, and optimised research design to capture the complexity of participants' subjective experiences across a diverse range of everyday activities and contexts. The main study involves collecting and analysing subcam data, conducting RIWs and RRIWs, and employing statistical analyses to uncover the relationship between demographic factors, behavioural variables, and MDM in everyday life. We recruited a diverse sample of participants using purposive sampling to ensure a wide range of experiences and perspectives are captured.

The following sections provide a comprehensive account of the research methodology for the final protocol we designed for the research.

4.2 METHODOLOGY OF THE MAIN STUDY

Human experience, as it occurs in real-world contexts, has to date been largely inaccessible to research. Scientists have usually resorted to asking people to self-report their experience through interviews and surveys or have had to rely on poor sources such as video surveillance. More recently, the experience sampling method was introduced to collect data from the context and content of individuals' lives (Hektner et al., 2007)While experience sampling provides valuable insights into individuals' experiences, it may interrupt the natural flow of activity and is limited by the predefined questions in the sampling protocol. These problems were precisely those that led to a halt of psychological investigations based on introspection at the beginning of the last century.

Today, mobile digital technologies that reliably record auditory, visual, and context data provide new possibilities for accessing and recording the situated human experience (Lahlou, 2011). One such technology is utilising the subcams for Subjective Evidence-Based Ethnography (SEBE) (Lahlou, 1999, 2006, 2011; Lahlou et al., 2015), which consists of three steps: First, participants ("subcamers") are equipped with miniature video cameras worn at eye level, called subcams, and record audio-visual material ("subfilms") of their own activity in situations pertaining to the research objective. The subcamers review the recording at their own pace, pausing when there is something interesting and commenting on it to the researcher, who tries to understand the underlying motives, goals, experience and rationale behind the behaviour. Finally, interpretations by the researcher are confronted with the subcamer's own interpretation, in a discussion. The use of subcams for capturing human experience has been explored in various contexts, such as observing cognitive work in offices (Lahlou, 1999) and understanding activity from the actor's point of view (Lahlou, 2006). A most interesting aspect of the technique is that during the RIW, the participants, cued by the recording, show a remarkably accurate remembrance of their actions and their intentions and emotions at the time.. The below example from the verbatim (as well as more detailed transcriptions in the Appendix) illustrates the surprising amount of details participants remember once confronted with a first-person recording of their own actions.

> **Participant 51:** *For example, that's what I meant early on, right? So, I walked past this, and I saw that the blanket was still hanging over there. Knowing that I'm cleaning the room later, which will mean that this needs to go somewhere else so I can properly brush it down, right? Now, this is a bit of trial and error, but I've been doing this for a couple of years now, and it just works well and so, having these routines that work actually allow me to turn off my brain or think about other stuff, or dance and sing without having to think about what's going on, right?*
>
> **Interviewer:** *Oh, yeah. For sure. So, let's go back a little bit. So, you have the broom in your hand and you put the broom across the wall somewhere, and here, you suddenly shift to folding your jeans.*
>
> **Participant 51:** *So, that is something I wouldn't have thought of, but I know roughly what needs to happen is I need to move this chair later on and I will probably be using it later on. That's what I was thinking: to get rid of these pants. But you see, there are still overlapping things. I'm still not done with the tidying up, but I decided that I need the broom, so I got the broom and it's sort of mixed up there, yeah. Mm-hmm and then the overall goal here is to get the room into a state where I can broom it. So, part of that is fetching the broom, part of that is, you know, tidying up, part of that is beating the mats and getting rid of them. So, I guess the overall goal is to trying to get the room ready. Then, I'm actually not thinking very much as we've seen, and some of the, you know, very bright blue denim on the*

chair caught my eye, and I was like, "Well, this needs to go", right? So, I get it out of the way.

While subcam studies offer unique insights into first-person experiences, it's important to acknowledge their limitations. Firstly, the effectiveness of first-person video can vary depending on the nature of the activity being studied. Subcams are particularly useful for capturing physical activities, manual tasks, and interactions with the immediate environment. They excel in recording cleaning, cooking, or organising activities where visual engagement is key. However, they may be less effective for capturing internal cognitive processes, abstract thinking, or activities that don't involve much physical movement or visual engagement. For instance, DM processes that are primarily mental, such as complex problem-solving or long-term planning, may not be fully captured by video alone. There is a potential concern that subcams may alter participants' behaviour due to awareness of being recorded. However, research has shown that this effect is minimal in practice. As Lahlou (2011) notes, *"Participants forget very quickly they wear the subcam... in a matter of minutes, the subject reverts to natural behaviour"* (p. 607). This observation is based on extensive use of the technique and comparison with external control cameras. Despite this reassurance, the possibility of reactivity should still be considered in data interpretation. Furthermore, subcams may not capture contextual information outside the participant's immediate field of view, potentially missing relevant environmental factors. Lastly, while subcams provide rich visual data, they may not fully capture other sensory experiences (like smell or touch) that could influence DM. Despite these limitations, when combined with retrospective interviewing techniques like RIW and RRIW (see page 51 for section 4.2 on Methodology of the Main Study), subcam studies provide a powerful tool for understanding everyday DM processes in their natural context.

Our research began with an exploratory investigation into the participants' everyday behaviour and DM. The process involved systematically observing and coding behavioural components in the subcam footage as participants engaged in various everyday activities. This approach was informed by the principles and benefits of behavioural observation and coding outlined by Heyman and colleagues (2014). Observing behaviour using Subcam footage allowed us to study behaviour in its natural context, providing a more ecologically valid understanding of psychological processes. Our behaviour observation and coding involved the systematic categorisation of observed actions or events based on emerging patterns.

This process enabled us to identify relevant behaviours and criteria of interest and develop our RIW topic guide to prepare for the next step of our research. By combining observational methods with SEBE, we captured and coded subtle or fleeting behaviours that may be difficult for individuals to report or remember accurately. Using Subcam footage allowed for a detailed examination of behavioural components that participants might have missed or forgotten, for example visual scanning, pauses, etc. Thus, through the initial step of our research, we obtained rich, descriptive data that provided a comprehensive understanding of areas and instances to focus on during the RIWs (e.g., activity type, location, time of day, familiarity with the task and/or environment, sudden changes in activity, rapid head movements, distractions, etc.).

In the second step of SEBE, the researcher and participant watch the recordings together and discuss the material in a RIW. This step allows for in-depth exploration of the participant's experience, with the subfilm serving as a detailed reminder of the activity. Finally, to allow for triangulation of the results, the researcher formulates findings and once more discusses the interpretation with the participant in an effort to match the etic and emic perspectives (Lahlou, 2011). Viewers looking at the resulting subfilm can, therefore, get a good view of the action itself from a first-person perspective. In addition, since subcamers tend to look at what they are doing, the subcam captures the focus of attention.

Figure 4

A researcher modelling the subcam (left) and another researcher conducting a RIW session (right)

Note. The image on the left is of a researcher modelling the subcam. The camera weighs only 7 grams and can be mounted on a pair of research glasses or the wearer's own (here). The image on the right shows the researcher (left) conducting a RIW session with a participant (right), through which he is taking control of the device to go through the subfilms.

SEBE complements experience sampling by providing a more comprehensive and less disruptive approach to capturing human experience. It allows for the collection of rich, contextual data without interrupting the natural flow of activity and enables researchers to ask in-depth, case-specific questions during the replay interviews. Such tools and methodologies enable capturing behavioural and DM aspects related to actions, making them particularly suitable for studying MDM in everyday life. During the RIW, the subject is replaced in the sequence of his phenomenological tunnel, creating a re-enactment of the situation in a detailed and realistic way; it triggers episodic memory (Tulving, 2002). In practice, participants remember their actions, intentions, and motions accurately and can explain in minute detail their mental processes at the time of action. The accuracy of their remembrance can be checked empirically by pausing the video, asking them what they did next, and then playing to video to compare what they say now they did then to what they actually did then. The degree of accuracy is amazing. While it is impossible to assess whether the participants do accurately remember their emotions and intentions at the time (if what they now say they felt and thought at the time is indeed what they felt and thought then), what they say always makes perfect sense, and the degree of assertiveness of the participants of the degree to which their remembrance is accurate is also amazing. It is very likely that replaying the perception-action loop from a first-person perspective actually triggers episodic memory. The SEBE protocol provides the research with an account of the mental processes as close as it gets to introspection since the participant accesses these states without the demands of action and time pressure.

These re-enactments are used throughout the research to make explicit internal states of the participant as (s)he experiences DM. Selecting moments from the subfilm when decisions are being negotiated and showing these clips to the users enables a reconstruction of the explicit and implicit thought processes behind the observed actions. Thus, the data reveals not only the DM situations but also how they are experienced and represented by the subject, and finally, the procedures and processes the participant engages in to make a decision.

Using activity analysis (see the section on Activity Theory), we analysed the subfilms through a combination of semi-structured interviews between the participant and the researcher. Figure 4 above demonstrates the subcam and RIW methodology. The image on the left is of a researcher modelling the subcam. The camera weighs only 7 grams and can be mounted on a pair of research glasses or the wearer's own (here). A complete manual of the subcam is included in Appendix B. The image on the right shows the researcher (left) conducting a RIW session with a participant (right), through which he is taking control of the device to go through the subfilms and reconstruct his activities with his thought processes and MDM experiences.

Below is an illustrative example of the RIW with P12, through which she explains the thought process of her activities. The RIW clip can be viewed using the following link: https://shorturl.at/h8yPL

> ***Interviewer:*** *Okay, okay, and in this one [recording] {00:07:52}, is the goal again to clean up the room?*
>
> ***Participant 12:*** *Yes, again, I'm tidying up the place and this was like, a different day and after my shower.*
>
> ***Interviewer:*** *Okay, so you're hoovering the room here {00:08:05}, and I'm wondering how you know if or when the room needs some hoovering? How do you decide whether to hoover the room?*
>
> ***Participant 12:*** *So, I try to do it twice a week, but it really depends on how the room is. If I feel like it's messy or if I can see a lot of dust on the floor, and if I just feel like it needs cleaning, I just clean it, so that would be a decision that I make*

based on how the room looks and whether I would need to clean it. […] So, like I said, I try to hoover the room twice a week, but which day of the week in particular definitely depends on how the room looks and how satisfied I am with how clean the room is.

***Interviewer:** Okay, that's really interesting! Is choosing which day in particular to hoover something you experience as a decision?*

***Participant 12:** Yeah, hundred percent. Yeah.*

***Interviewer:** Okay, cool. Also, how do you know how much hoovering is enough? As in like, how do you when to stop hoovering and that it's like, enough?*

***Participant 12:** I mean, I just go over the entire space and based on like, experience, it's usually pretty much clean after that. So, again, it's also visual feedback. So, it's a bit of both experience with cleaning hoovering the room many many times and also visual feedback.*

***Interviewer:** Fantastic! You also hoover the kitchen. Was that always part of the plan? Do you always hoover the kitchen as well as your room?*

***Participant 12:** Yeah, because I'm sort of a person who likes everything being clean, like I even hoover the bathroom, but yeah like, I need every space that I'm living in completely clean.*

***Interviewer:** Yeah, I see. Also, I'm curious to know if you remember what was going on in your mind as you were hoovering.*

***Participant 12:** It's just, cleaning is very relaxing for me, so I think it was just a nice break from work and everything. It just makes me happy when I see everything clean. So, I was just smiling when I was doing this and like, enjoying it, but the other thing could have been that, because I'd just taken a shower, I was also trying to make a mental list of all the things I have to do. So, I was thinking about what else do I have to do that day, so [I] was just making a mental checklist as I was hoovering and was thinking ahead because the hoovering doesn't need much conscious attention of course.*

***Interviewer:** That's really interesting! You mentioned a mental checklist, is this something you do every day?*

***Participant 12:** Yeah, definitely! I make a mental checklist of all the things I need to do that day and then cross them off mentally one by one.*

***Interviewer:** Interesting! You take a mop here {00:11:28} and mop the floors after you're done with hoovering. Is this always part of your cleaning routine? Like is it always with the same structure, like you hoover first and then mop?*

***Participant 12:** Yeah, that's how I always clean. It's like, hoover first and then I mop the floors. It's not something I have to decide on really. The decision is whether to clean or not, but if I decide to clean, then this is how it's going to be.*

Interviewer: *Yeah, that makes perfect sense. Again, as you're mopping the floors here {00:12:01}, are you trying to get some visual feedback like you did with when you were hoovering the place?*

Participant 12: *Yeah, like, I go over the surfaces once, and if I felt like there was the need to go over it again, based on the visual feedback, I'd go over it again, but at that point, I keep it at one [go]. {00:12:25} There I realised I ran out of mopping liquid, which is why I just stick to mopping my room, because otherwise I would have mopped the kitchen and the bathroom as well.*

Interviewer: *Yeah, right. Do you remember why you went in the kitchen here {00:12:35}?*

Participant 12: *Just to wash my hand up because I was finished with the cleaning.*

Interviewer: *Was washing your hands something you experienced as a decision?*

Participant 12: *No, I mean, because I do it every time, I wouldn't say I felt like I decided to do it [wash hands]. I mean, especially now with Covid, you're just so prone to washing your hands after everything. So, it's mostly a habit by now that I'm so used to.*

The subcam has already been tested in various environments. For instance, Hollan and Hutchins (2009, 2010) have used it to examine the activity of pilots. Le Bellu, Lahlou and their colleagues (2010) and Fauquet-Alekhine (2017) have explored its potential in transferring experience in areas of high technology. Their work also developed protocols for expertise tracing and transfer in classic (non-emergency) situations on-site in real work conditions for novices' training (Le Bellu et al., 2010). The capture device (subcam) is used to collect events and actions in situ, and debriefing techniques for recovering cognitive processes already exist (Jonassen, 2016; Lahlou, 2010, 2011). In her doctoral thesis, Sophie Le Bellu extensively used it extensively to analyse professional activity and create training films. What is missing is the adaptation of the protocols for capturing more generic DM.

Moreover, the subcam has also been utilised by researchers affiliated with the LSE Department of Psychological and Behavioural Science to study police practice (including DM under pressure) (Rieken, 2013; Stangeland, 2016) from the first-person perspective of officers, DM in Intensive-Care Units under pressure (Heptonstall, 2015; Zhang, 2015), consumers' DM processes and evaluation of goods (Gobbo, 2014), to study social media and addictive behaviour (Everri, 2017; Heitmayer & Lahlou, 2021) and to understand locked smartphone use among young adults (Heitmayer, 2021).

Developing the coding scheme and identifying key behavioural variables through the exploratory study and pilot studies provided a solid foundation for understanding MDM in everyday life. However, to further enhance the validity and reliability of our findings, we recognised the need for a more robust and participant-centred approach to data collection and analysis.

While the SEBE methodology and RIWs allowed us to capture participants' subjective experiences and gain valuable insights into their DM processes, we sought to develop a protocol that would enable participants to directly engage with their own data and provide more detailed and accurate accounts of their MDM experiences. This realisation led to the development of the RRIW protocol (see the following sub-section), a novel extension of the SEBE methodology that aimed to empower participants as active co-creators of research and to minimise the potential for researcher bias in the interpretation of the data. The following section will discuss the RRIW protocol in detail, highlighting its unique features and its role in enhancing our research on MDM's robustness and ecological validity in everyday life.

4.2.1 Reinforced Replay Interviews (RRIW)

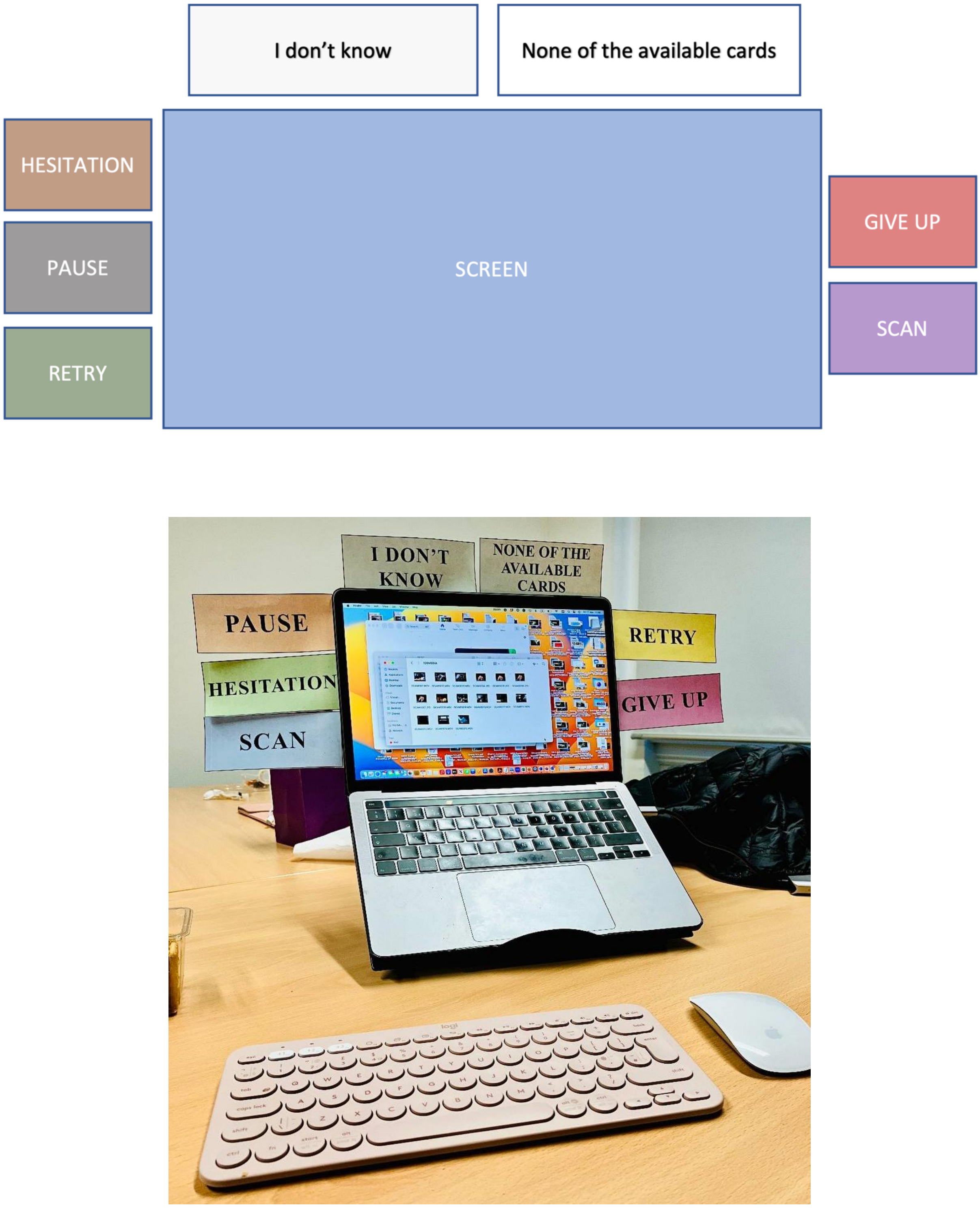
Aiming to rely less on the researchers' intuition and more on the participants' subjective experience, we developed coding cards based on the identified variables through our pilot study (see Appendix F). We identified key observable variables related to MDM, such as pause, hesitation, scan, retry, and give up (see Coding and Concepts for a full description and examples). The terminology used for the card titles and their description was developed based on a textual analysis of the open-ended descriptions of the situations from participants' own language, as captured during the exploratory study (see Appendix E for our data analyses throughout the Exploratory Study).

These variables were used to create the set of visual cues with derived titles and descriptions. We arranged the visual cues around the screen on which we replayed the footage for the participants.

7 cards were developed and put next to the screen for the RRIW. The card-based coding protocol included *Pause, Hesitation, Scan, Retry, Give Up, I don't know,* and *None of the cards*. The cards were inserted around the screen (see Figure 5).

Figure 5

Schematic (above) and actual (below) illustrations of the visual cues around the screen for RRIWs



The RRIW protocol involves participants reviewing their own SEBE recordings and using the card-based system to code instances where they experienced a breach in the fluidity of their activity. Participants were instructed to pause the video whenever they noticed such a breach and then select the card that best described their subjective experience of the situation. Additionally, participants were asked to identify moments of subjective micro-decisions.

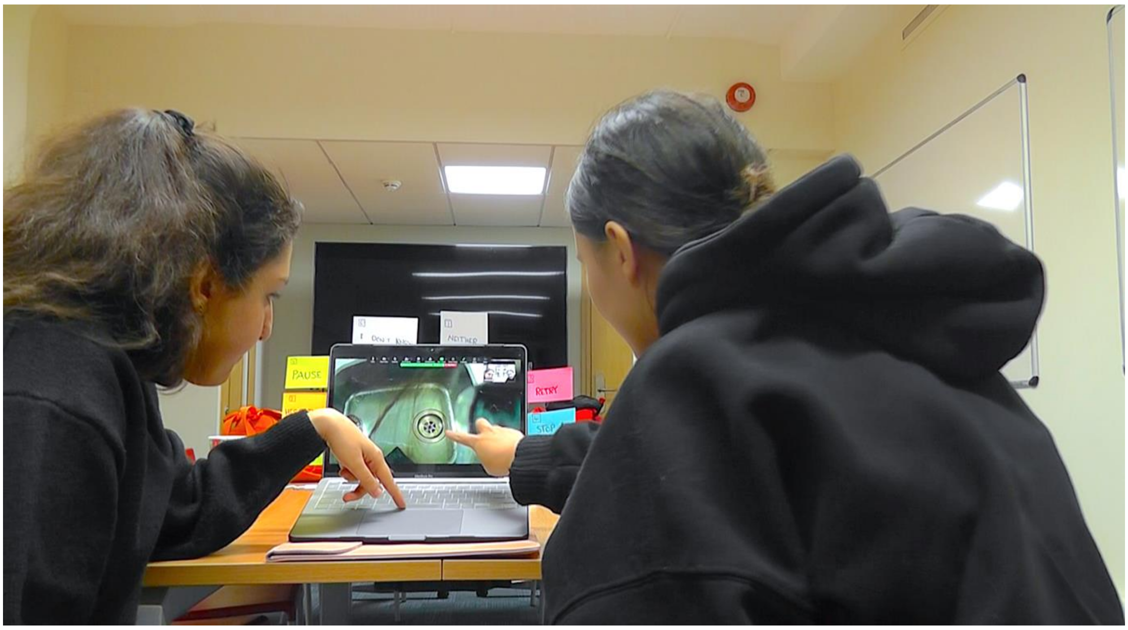
For the pilot studies, two participants were recruited. Each participant coded approximately 30 minutes of their own Subcam footage. The participants were provided with detailed instructions on the card-based coding system and the RRIW process.

Figure 6 illustrates the RRIW pilot study with one of the participants. It shows how the participant used the cards as visual cues to code her own data and confirm moments of activity disruption and micro-decision.

The RRIW sessions were conducted in a controlled setting, with the researcher present to guide the participants and answer any questions. This rigorous process ensures the reliability of the results.

Figure 6

The researcher and the participant during the RRIW pilot study



Note. The participant is choosing the card which best describes the situation following a breach she noticed in the fluidity of her activity.

We often observed throughout the RRIW sessions that participants took control of rewinding and pausing the footage without the need to ask them to do so. They proactively paused the footage whenever they experienced a breach in their activity flow and used the visual cues around the screen to code their subjective experience of the situation. Thus, it was of utmost importance to ensure that participants had access to an additional keyboard and mouse and could conveniently control the Subcam footage playback.

The RRIW procedure was as follows:

1. The researcher explained the visual cues and codes to the participant, providing examples of each, and ensured that the participant understood what each card included.
2. The researcher played the subfilm for the participant and asked the participant to pause the video whenever they experienced a break in the fluidity of their activity.
3. Following a pause in the video, indicating a break in the fluidity of activity, participants chose the card that best described their subjective experience of the situation.
4. The researcher asked (if not already disclosed spontaneously by the participant) whether the situation was experienced as making a micro-decision by systematically asking the participants, "Did you experience this instance as making a decision?".

Figure 7 illustrates our updated RRIW setting. It is followed by images of participants taking control of the footage and pointing to the behavioural code that best describes the subjective experiences of the disruptions and reorientation.

Two complete RRIW sessions can be viewed through the following link: https://shorturl.at/2YStb.

Figure 7

Images of various RRIW sessions with the participants

Note. The images demonstrate how participants took control of the footage, paused whenever a micro-decision occurred, and pointed towards the card, which best described the subjective experience of the situation.

Below is an extraction of the RRIW verbatim with Participant 55, followed by an example from Participant 48, as they choose a coding card:

> *"Hesitation…a lot of hesitation because I'm holding a plate, thinking about what I should do with the plate? A lot of hesitation like…after the hesitation, I decide, "Okay, now the small plates will go here."*
>
> *[…]*
>
> ***Interviewer:*** *Are you scanning?*
>
> ***Participant 55:*** *No, I'm hesitating. I'm like hesitating for like everything. I hesitated like four times because I was trying to decide "what do I do next?" So, it's a hesitation and then a decision.*
>
> ***
>
> ***Participant 48:*** *Also, I put the bin somewhere [else] because obviously, I have to move it because I can't vacuum [otherwise]. So, it's kind of…yeah, it's part of my flow state, it's not an active decision.*

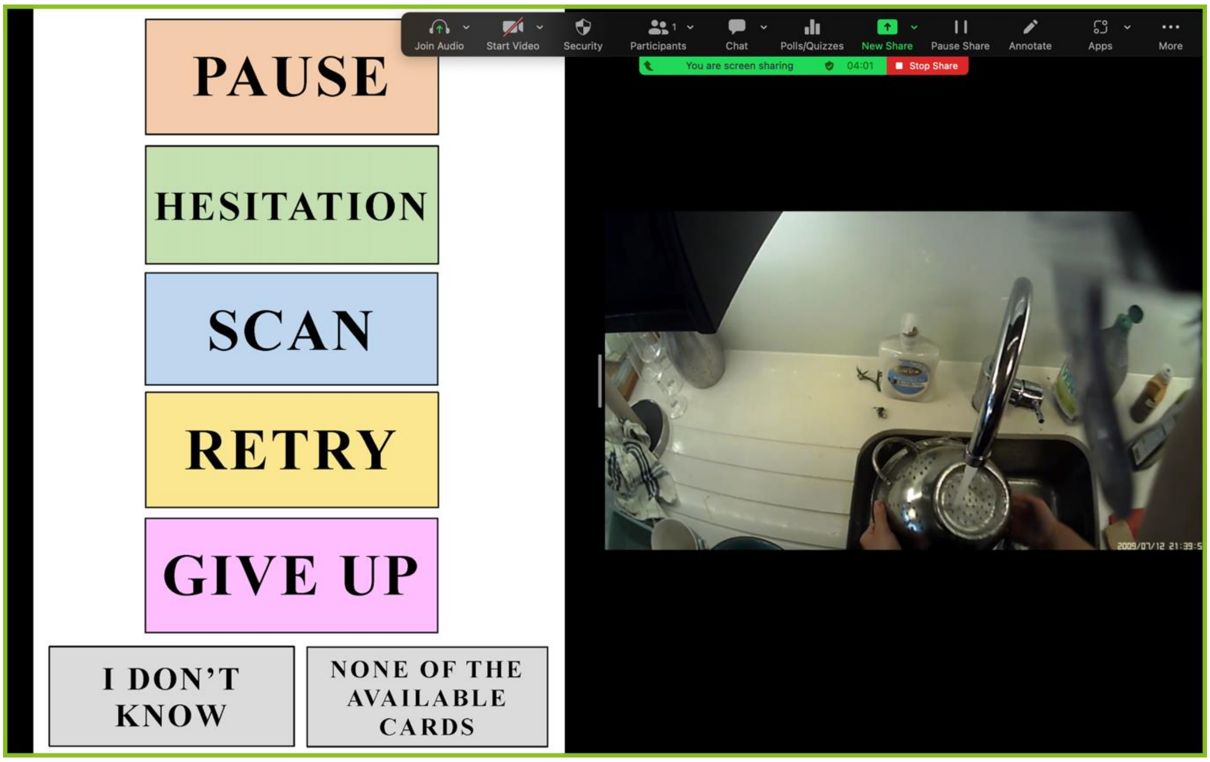
So, the RRIW can be conducted as an extension of a classic RIW protocol, where the subfilm is watched by the participant, discussed with the researcher, and the conversation is video recorded (to see what happens on the screen the participant is commenting). On top of that, the RRIW adds the set-up where the participants themselves choose the code cards to add some specific and standardised coding. The choice of the cards is done as part of the conversation with the researcher, which also enables capturing comments about the reasons for this self-coding. In this specific study, because the RRIW protocol was constructed gradually during the research, only 51 of the 60 participants of the final study were subjected to the RRIW, and the RRIW sessions took place in a second session after an RIW had already been done. This was done by coming back to the participants and asking them to code their recordings more precisely and by themselves. The final codes used are the ones resulting from this final coding. What is coded is, therefore, firstly, a break in the activity flow for which we ask the participant to pause the video as soon as their activity flow is breached. Therefore, each row in our datasheet is an instance of break in the activity, as experienced by the participant. Secondly, we ask participants to choose one of the seven cards (pause, hesitation, scan, retry, give up, I don't know, and none of the available cards) which best describes their experience of the situation following the breach in the flow. Lastly, we ask whether they experienced this situation as taking a micro-decision. Therefore, each instance we code as a separate row in our datasheet is determined by a breach in the activity flow followed by the behavioural events and, finally, experiences of making micro-decisions.

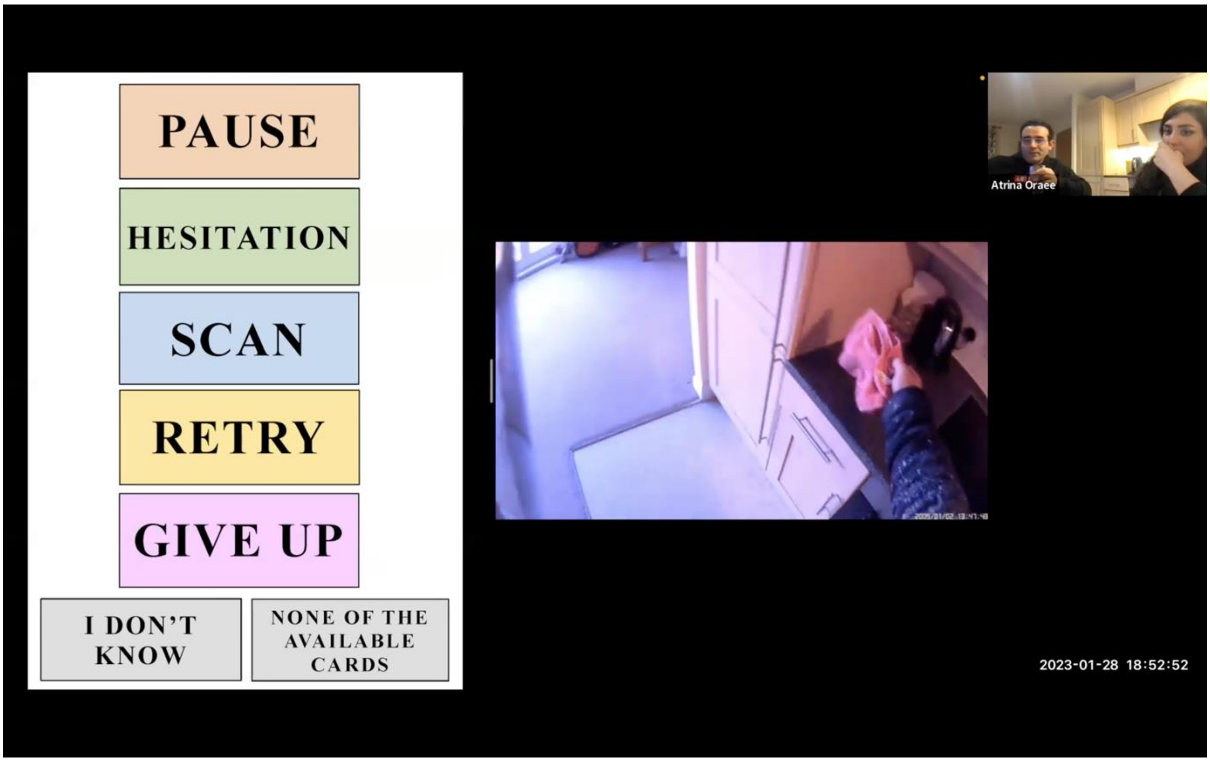
In situations where in-person RRIW sessions were not possible, an online session was conducted with electronic copies of the behavioural codes arranged around the shared desktop view to make the protocol easier to carry out. The same RRIW procedure was then followed. Through such a remote design, we managed to conduct RRIWs with participants from whom we no longer had access due to physical distance.

Such a protocol can be followed using any video conferencing platform, such as Zoom or Google Meet. The images below show samples of online RRIW sessions with participants.

Figure 8

Online RRIW sessions with the digital visual cues arranged next to the footage for participants





4.2.2 Template for Presenting Research Findings

One of our objectives was to develop an effective and engaging template for presenting our research findings. We aimed to create a format that would allow us to visualise our data and variables clearly and comprehensively while providing a compelling narrative showcasing the rich, qualitative insights gained from the Subcam footage and participant interviews.

To achieve this, we developed a novel storyboard-based template (see Figure 9) that integrates the Subcam footage timeline with the participant's verbatim comments. This innovative approach allows us to contextualise each thumbnail image within the broader narrative of the participant's experience, providing a more holistic and immersive understanding of the MDM processes captured in the data. The top section of the template presents a sequence of key frames from the Subcam footage, illustrating the unfolding of the activity and the specific moment of interest. Below the frames, participant verbatim comments from the RIW and RRIW sessions are included, offering insights into their subjective experiences and thought processes. The bottom section displays the behavioural codes assigned to the observed actions, as well as the DM variables identified through the analysis.

The storyboard template is designed to present the SEBE data in a sequential manner, with each thumbnail image representing a key moment or event in the participant's experience. We embed the participant's verbatim comments directly into the storyboard template to enrich the visual narrative. These quotes, extracted from the RIWs and RRIWs, provide valuable insights into the participant's subjective experience and help to illuminate the underlying cognitive processes and motivations driving their actions. In doing so, we attempted to illustrate and appropriately visualise the activity reconstruction with the micro-decisions and/or behavioural codes embedded. Thus, in addition to the thumbnail images and verbatim comments, the storyboard template also incorporates the relevant codes and variables identified through our analysis. Each thumbnail image is accompanied by the corresponding codes, such as the type of micro-decision or the associated behavioural variables (e.g., pauses, hesitations, scans). To further enhance the usability and interpretability of the storyboard template, we include the shot number and timestamp for each thumbnail image.

The development of this storyboard template was an iterative process that evolved throughout our research. We experimented with different layouts, visual elements, and information hierarchies to find the most effective and engaging format. The final storyboard template, as shown in Figure 9, represents the culmination of this iterative design process.

Figure 9

Storyboard-based template for presenting research findings on MDM in everyday life

Note. The template integrates Subcam footage, participant verbatim comments, behavioural codes, and DM variables to provide a holistic and comprehensive representation of the MDM process.

In sum, our research used a mixed-methods approach, combining data from real-world everyday life gathered using the SEBE protocol to provide information about participants' high-frequency micro-decisions while engaging in various DM processes throughout their typical daily activities. We conducted the research in several stages, each building upon the findings and insights gained from the previous stage. These stages were designed to ensure a comprehensive and iterative approach to investigating the subjective experience of MDM in everyday life. By starting with an exploratory study and pilot studies, we gradually refined our research design, sampling criteria, and methodological and coding protocols before embarking on the main data collection and analysis phase.

The primary objectives of the main study were as follows:

1. To capture the subjective experience of MDM in naturalistic settings using the refined RRIW protocol, which was developed and tested during the pilot studies.
2. To identify the prevalence, patterns, and processes of MDM across a diverse range of everyday activities and contexts which involve various micro-decisions.
3. To explore the cognitive, affective, and contextual factors that influence MDM in everyday activities using the revised coding scheme and the updated activity model developed during the pilot studies.
4. To conduct a comparative analysis of MDM across different contexts through typical everyday tasks to reveal potential variations in MDM processes and experiences and test the findings' generalisability.
5. To develop a theoretical framework for understanding MDM in real-world contexts based on the empirical findings and insights gained from the study, incorporating the concepts of fluid flow, diversion, disruption, and orientation identified in the pilot studies.
6. To address the limitations identified in the pilot studies, such as the need for a more comprehensive coding scheme, a larger and more diverse sample, and a more iterative approach to data analysis and model development.
7. To refine and validate the basic activity model proposed in the pilot studies by re-coding the entire dataset of the exploratory and pilot studies (that is why some RRIW had to be done online, recontacting the participants who already had done a RIW), focusing on the behavioural components that precede and follow instances of MDM. This approach takes into account the insights gained from the analysis of our initial proposed models, which revealed the need for a more comprehensive and nuanced understanding of the complex interplay between activity flows, disruptions, and MDM in naturalistic contexts. This was to see what results would be obtained if we also included in the statistics, in separate calculations, the analysis of the substantial material collected in the exploratory phase.
8. Finally, to contribute to our main research endeavour: the development of a nuanced and robust understanding of the complex interplay between activity flows, disruptions, and MDM in naturalistic contexts, informing future research, interventions, and applications related to DM in real-world settings.

The main study employed a mixed-methods approach, combining the collection of SEBE data using subcams with the refined RRIW protocol, in-depth qualitative analysis of participants' verbalisations, and quantitative analysis of the prevalence and patterns of MDM across different contexts and participant characteristics. The study aimed to recruit a diverse sample of participants, considering factors such as age, gender, and cultural background to enhance the generalisability and ecological validity of the findings. The details of our methods and data are explained throughout the following sub-sections.

4.2.3 Sampling criteria and data collection

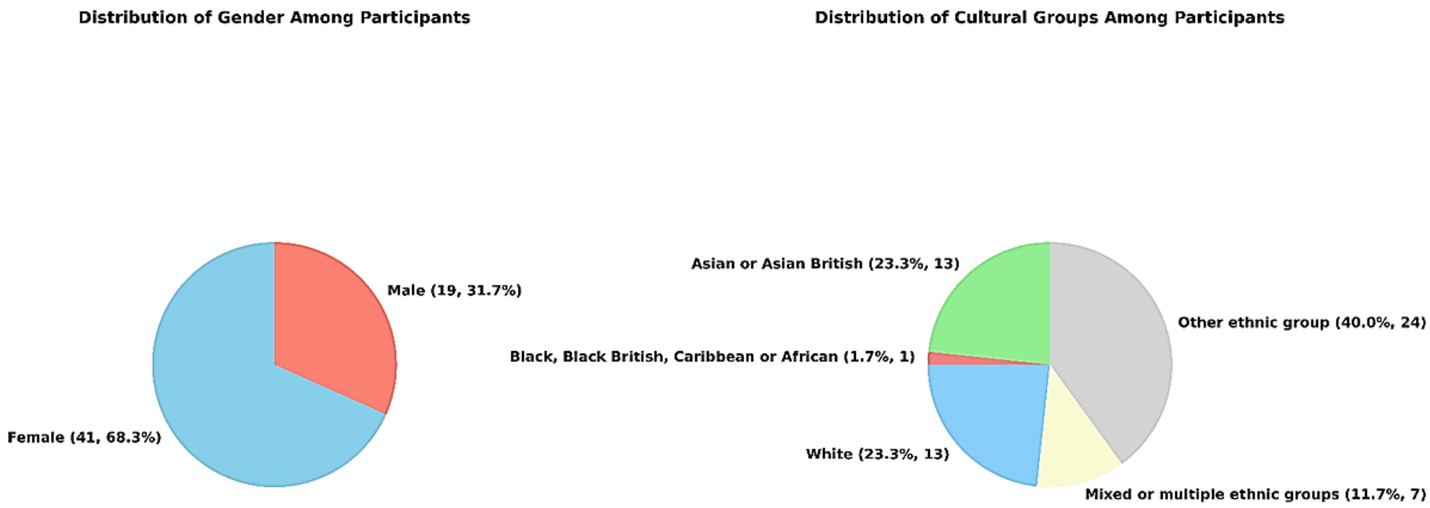
The main study employed a purposive sampling strategy to recruit participants based on specific criteria, ensuring diverse experiences and perspectives in order to capture a large diversity of participants. The sampling criteria were expanded based on the insights gained from the exploratory phase and pilot studies. The key sampling criteria included:

- Age: Participants aged between 22 and 60 years old.
- Gender: A balanced representation of male and female participants.
- Occupation: Participants from various occupational backgrounds.
- Education level: Participants with diverse educational backgrounds.
- Ethnicity/culture: Participants from different ethnic groups to ensure cultural diversity.

The main study recruited a diverse sample of 60 adults living in the UK, aged between 22 and 60. The sample comprised 41 females (68%) and 19 males (32%), ensuring a balanced gender representation. Participants were categorised into five ethnic groups following the UK's Office for National Statistics (ONS): Asian (or Asian British) (23%, 14 individuals), Black, Black British, Caribbean, or African (1%, 1 individual), White (23%, 14 individuals), Mixed or multiple ethnic groups (11%, 7 individuals), and Other ethnic groups (40%, 24 individuals). For this categorisation, we adhered to classifications established by the ONS, which are designed to reflect the socio-cultural and demographic composition of the UK population (Office for National Statistics, 2021). Using these established categories ensures that our research is grounded in a recognised framework, enhancing the validity and reliability of our findings while enabling comparability with other studies and statistics. The diverse ethnic composition of the sample allowed for an examination of potential cultural influences on MDM: We were not specifically interested in ethnic differences but rather ensured that we covered a diverse array of cultural backgrounds. Figure 10 represents the distribution of ethnic/cultural groups and gender among participants. The left pie chart illustrates the distribution of gender among participants and the right pie chart depicts the demographic background of the sample population.

Figure 10

Distribution of Gender and Cultural Groups Among Participants



4.2.4 Data Collection

The main study employed the SEBE methodology for data collection, which included the following components:

1. SEBE recordings: Participants were asked to wear miniature cameras (subcams) to capture first-person perspective video footage of their everyday activities. These cameras are light (7 grammes), unobtrusive, and worn on a pair of glasses. They can be either fixed to the participant's glasses if they wear glasses or put on a pair of inconspicuous, non-corrected glasses that is given to the participant. Decades of this protocol show the participants forget they wear the subcam after a few minutes, and their behaviour can be considered natural in the vast majority of the recordings (see Lahlou, 2006, 2011; Lahlou et al., 2015, 2015 for a discussion). Participants were instructed to record activities they perceived as part of their typical daily routines. Participants were encouraged to review and edit the footage before sharing it with the

researchers to ensure their comfort and privacy, following the ethical guidelines of SEBE (see Ethical Considerations). The protocol was approved by the LSE ethics board in May 2021 (see Appendix C for the ethics approval).

2. RIWs: After the SEBE recordings, participants engaged in RIWs with the researchers. During these interviews, participants reviewed their footage and provided detailed explanations and reflections on their subjective experiences, thought processes, and DM moments.
3. RRIWs: Participants also participated in RRIWs, which involved using the refined card-based coding system developed during the pilot studies. Participants coded their own SEBE data by identifying instances of breaches in the fluidity of their activity and selecting the appropriate card to describe their subjective experience. They also identified moments of subjective micro-decisions.

The table below provides an overview of the total data collected through each of the 3 above steps:

Table 2

Summary of data collected during the research

Data Type	Total Amount	Number of Participants	Average per Participant
Subcam	57 hours, 49 minutes, 42 seconds	60	57 minutes, 50 seconds
RIWs	47 hours, 23 minutes, 45 seconds	60	47 minutes, 24 seconds
RRIWs	32 hours, 5 minutes, 11 seconds.	51	31 minutes, 41 seconds
Total subcam footage collected		57 hours, 49 minutes, 42 seconds	
Total subcam footage analysed through RIWs		57 hours, 49 minutes, 42 seconds	
Total subcam footage analysed through the final protocol (RIWs + RRIWs)		49 hours, 9 minutes, 20 seconds	
Total conducted confrontation interviews (RIWs + RRIWs)		79 hours, 28 minutes, and 56 seconds	

Note. The table includes Subcam footage, RIWs, and RRIWs, with total amounts, average durations per participant, and the number of participants involved in each stage.

The behavioural components (pause, scan, etc.) and the participants' comments were analysed in isolation and sequences (which component follows which). This enabled the construction of a more generic underlying model.

Based on the initial findings, a basic activity model in the form of an activity tree was considered to identify instances of MDM throughout the activity process and situations in the cleaning activity (see figures in Appendix F). We refined and updated the model by analysing Subcam footage from various everyday activities and incorporating insights from RRIWs.

The revised model included, as the initial model we developed through our pilot studies (see Appendix F), various observable activity components such as fluid flow, diversion, disruption, and orientation, which were found to be crucial in understanding the occurrence of MDM in everyday life (fluid flow, disruption, etc.). These activity components are combined in the production of the activity trajectory. These processes come with some behavioural manifestations, and we interpret their function psychologically. The initial model was used in the development of our codes and concepts to further investigate through our final and refined research protocol and was then complemented as described below. The following sub-section explains our identified activity components, codes, and concepts in detail.

4.2.5 Coding and Concepts

Through our exploratory study and pilot studies, we developed an initial activity model that provided a framework for understanding the key components and processes involved in MDM in everyday life. The model, which emerged from thematic analysis of the Subcam footage and RIWs, helped us to identify critical activity components such as fluid flow, diversion, disruption, and orientation.

These components served as the foundation for our investigation of MDM in the main study, guiding our focus and shaping our research questions. However, to further refine and validate the model, we needed to delve deeper into these activity components and examine their relationships with the behavioural variables and MDM processes identified through our coding and concept development. In this section, we provide a detailed explanation of the activity components and the key concepts that underpin our research as they emerged through the behaviours observed and the comments of the participants in the RIWs and RRIWs.

4.2.5.1 Activity initiation

Activity Initiation involves setting goals based on desires or needs. This involves motivations and intentions but also the influence of social institutions, stimuli, and roles. We observe this is our data through the initiation of an activity, and participants verbalise this explicitly by explaining their intentions, reasons, rationalisations, goals and sub-goals. Activity initiation refers to the starting point of an activity, where participants set a goal or intention and begin to engage in actions directed towards achieving that goal.

Operationally, activity initiation manifests in our Subcam footage as the moment when participants start a new activity or task, often characterised by a clear shift in their focus, behaviour, or environment. In our coding scheme, we identified instances of activity initiation by looking for specific indicators in the subcam footage, RIWs, and RRIWs, such as:

- ***Shift in focus or behaviour***: The Subcam footage reveals a noticeable change in participants' focus or behaviour, indicating the beginning of a new activity or task.
- ***Preparatory actions:*** Participants engage in actions that serve to prepare for the upcoming activity, such as gathering necessary materials or tools or moving to a different location.
- ***Explicit goal setting:*** Participants verbalise their intention to start a new activity or task, often in the form of a clear goal statement (e.g., *"I'm going to start cleaning the kitchen now"*).

During RIWs and RRIWs, participants often described the thought processes and motivations underlying activity initiation, providing insight into how they set goals and made decisions to start new activities. For example:

> *"I decided to clean up and tidy up a bit, so the goal here is cleaning and decluttering my room."* ***– P24***

> *"There are still some stuff left to clean in the kitchen, so we start cleaning there."* ***– P39***

> *"So, yeah, I had a dinner the previous night, so I, sort of, clean up, as well as having breakfast. Yeah, I just woke up so I have breakfast first so, now it's just about starting to prepare breakfast. […] I took my book to read. […] So here, I'm about to prepare tea like every morning, so I take the milk warmer, which is right here. I felt like having coconut milk because, for some reason, I like having coconut milk before having the proper tea and then oat milk to put in the tea because it doesn't mix correctly, and I'm very specific about my tea."* ***– P22***

"I'm about to start cooking now [because] it was a while since I last ate, and I was feeling hungry; I also needed a break." – ***P47***

4.2.5.2 Fluid flow

Fluid Flow represents seamless progression towards goals. Fluid flow is a key activity component in our model, referring to the smooth, uninterrupted progression of activity, characterised by automatic or habitual actions and minimal conscious DM. In the context of our research, fluid flow represents a state in which participants engage in everyday activities with a sense of ease, efficiency, and *"being in the zone"* – P1, P14, P28, P39.

We observed fluid activity flow in our data as a type of activity (as opposed to disrupted activity explained below), which is an undisturbed chain of actions that follow one another effortlessly. Fluid activity flow manifested in our data through a ***fast and frictionless chain of continuous actions***, and participants explained it as ***not having to think or decide much over what they are doing***, often even not thinking about the task at hand at all. Participants move from one action to another without noticeable breaks or interruptions, suggesting a sense of continuity and flow in their activity. Fluid flow is often characterised by a sense of efficiency and speed in participants' actions as they navigate tasks and environments with minimal effort and deliberation.

"Washing dishes is very fluid and slow. Right? Doesn't need much thinking, does it? So, I'm already thinking about something else as soon as start." – ***P60***

"It's amazing with cleaning because it's really meditative, and I can just put on some music and switch off my brain and listen to the music while I clean." – ***P18***

"Well, I'm not actively thinking; I just vacuum. If I notice something, like a stain or if somewhere is particularly dirty, that's a different story, but otherwise, it's just vacuuming. I'm probably already thinking about something else." – ***P29***

"I wasn't thinking anything specifically. Yeah, because it's just, you know, doing laundry. Yeah. I've been staying here [in the accommodation] for six months, and I know where everything is, so there's not much to think about or make decisions. Yeah." – ***P21***

4.2.5.3 Diversion

Diversion represents minor breaks in the fluid activity, which do not require significant reorientations by the participant. They mostly manifest as "add-on" opportunities presented by the environment to use up more cognitive and physical resources and ensure efficiency until satisfaction is reached. Diversion thus refers to a temporary departure from the main course of an activity, often triggered by an unexpected event or opportunity but not significantly disrupting the overall goal or intention.

Operationally, diversion manifests in our Subcam footage as a brief shift in participants' focus or behaviour, followed by a return to the primary activity. In our coding scheme, we identified instances of diversion by looking for specific indicators in the Subcam footage and RIWs such as a ***brief shift in focus of attention*** (e.g., participants momentarily attend to a stimulus or event) and a quick return to the primary activity and goal pursuit ***without significant disruption*** to their overall goal or progress. Diversions do not substantially alter participants' goals or intentions, and they are able to maintain continuity in their activity despite the momentary shift. During RIWs and RRIWs, participants often described diversions as minor *"side tracks"* or *"distractions"* that did not significantly impact their overall activity, so they *"might as well"* do it. For example:

> *"I went to the table to take the plates, but I also changed the music because I was already there, so I thought I might as well." **– P19***
>
> *"Yeah, I'm pretty sure the goal was to clean up the room and the mess I'd made from the night before, and I go to the kitchen after this, so I also want to take everything that doesn't belong in the room with me since I'm already going downstairs, so I might as well just take anything that needs to go downstairs, or belongs in the kitchen." **- P49***
>
> *"I'm trying to take as much [hair] as I can with hand because I'm going to the kitchen anyway, so…." **– P32***
>
> *"Oh, this is a toilet paper, and I put it in the bathroom now because, again, I don't want to walk again." **– P40***
>
> *"I'm going downstairs, so I just might as well." **– P20***
>
> *"I'm going to the kitchen to have breakfast, but I have dishes left in my room from last night, so I just take as many dirty dishes I can since I'm already going to the kitchen." **– P58***

4.2.5.4 Disruption

Disruption refers to a significant breach or interruption in the flow of activity, requiring a reassessment of goals, priorities, or strategies.

Operationally, disruption manifests in our Subcam data as a noticeable break in participants' ongoing activity, often accompanied by a shift in their focus and behaviour. We observed disruptions occurring for external reasons (environmental cues such as when the participant is distracted by something, e.g., they heard something, saw something, etc.) or for internal reasons (self-disruptions). In our coding scheme, we identified instances of disruption by looking for specific indicators in the Subcam footage, RIWs, and RRIWs:

Significant pause or hesitation (see our explanations below on behavioural variables for details): Participants exhibit a pronounced pause or hesitation in their activity, often accompanied by nonverbal cues such as facial expressions or body language indicating uncertainty or confusion.

Verbalised uncertainty or frustration: Participants express uncertainty, frustration, or other negative emotions related to the disruption, often in the form of self-talk, or comments to the researcher during the RIW.

Change in goal or strategy: The disruption prompts participants to reconsider their current goal or approach, leading to a reassessment of priorities or the adoption of a new strategy.

During RIWs, participants often described disruptions as unexpected or unforeseen circumstances and events that have massively disrupted their otherwise fluid chain of actions and require active thinking and a *"change of plan"*. They provided insight into the cognitive and emotional processes involved in navigating these disruptions and making micro-decisions to reorient (see Reorientation below) their activity. For example:

> *"I wanted to use lettuce for salad, but because we didn't have lettuce, I had to change the plan [...]" –* ***P24***
>
> ***
>
> ***Interviewer:*** *Alright. So, here, it seems like you're struggling with opening the lid. Do you remember what was going on here?*
>
> ***Participant 37:*** *Yeah, it was very tough to open them [jar] and doesn't work. I went to the drawer because I wasn't sure, like, if we have something that you use to open the jar with [jar opener], so I checked the drawer again cuz I thought we had it, but we don't.*
>
> ***Interviewer:*** *Did you experience this instance as a decision?*
>
> ***Participant 37:*** *Yeah, it's definitely a disruption [sic]… and then {00:05:24} I'm checking in the other drawer, but no, nothing here. What a shame! [both laugh]*
>
> ***Interviewer:*** *Did you know exactly what tool you were looking for?*
>
> ***Participant 37:*** *I have a mental image of the actual device. It's a device we have in Germany as well. It's like, made of metal, and it's kind of opening up like an arch, and then you clip it on [the jar], and then you twist it, but we didn't have it there."*
>
> ***

> *"Yeah, I decided to go to the nearby corner shop, and it was so annoying because I thought it's only a short trip [to the shop], so I will just slip in them [shoes] and not really wear them, but then it was so uncomfortable that I decided "Okay, we have to put them on", even though I was annoyed by it, so I was like "Whatever…gonna do it." – **P41***

4.2.5.5 Reorientation

Reorientation involves adjusting strategies in response to internal or external disruptions, blending intuitive and analytical thinking to navigate new circumstances. Reorientation refers to the process of gathering information, exploring options, and making judgments to navigate a disruption and regain a sense of direction or purpose.

Operationally, reorientation manifests in our Subcam footage as a period of ***active information-seeking***, MDM, and problem-solving following a disruption in the activity flow. In our coding scheme, we identified instances of reorientation by looking for specific indicators in the Subcam footage and RIWs:

Information-seeking behaviour*:* Participants actively scan their environment, seek out new information, or consult external resources (e.g., instructions, online guides) to help them navigate the disruption.

Evaluation of options: Participants consider multiple courses of action or solutions to the problem at hand, often verbalised as a series of *"if-then"* statements or weighing of pros and cons.

MDM and problem-solving: Participants make conscious micro-decisions about if and how to proceed with the activity, often involving a degree of creativity, flexibility, and adaptation to the new circumstances.

During the RIWs, participants frequently described the thought processes and strategies involved in reorientation as *"trying to figure out"* or *"not sure what to do next"*, providing insight into how they navigated disruptions and made micro-decisions to get back on track. For example:

> ***Participant 24:*** *Okay, so what I was trying to do was to try to use as many ingredients as possible, but at the same time make a tasty salad. That's why I'm thinking, and I'm hesitating which items to pick, because it's better to use all the ingredients, but at the same time if I use all of it, I might not be able to make a very good salad. So, I'm trying to reach something in between. I make the most out of the of the available items and at the same time have the good taste as well.*

Interviewer: *Got it. Did you feel like you made any decisions over which ingredients to pick?*

Participant 24: *What I wanted was to find lettuce because I wanted to use lettuce at first, but we were out of lettuce. So, that's why I had to change my decision. I wanted to use lettuce for salad, but because we didn't have lettuce, I had to change the plan. I had to pick other items like tomatoes, whatever there is [available in the fridge].*

***

Interviewer: *So, what are you looking at here?*

Participant 52: *So, for that [the box of vegan meat alternative], I was looking at the indication for recycling purposes because I know that the cardboard part is recyclable, but I wasn't sure if the plastic box was because I know that they [vegan food packages] contain it [recycling indication signs and symbols], but this time I was struggling to find it. So, I was just looking at it for this specific box I was checking if it's recyclable or not. So, I'm looking for the indication right now. I'm looking at the bottom and sides to see if there are any signs, and I'm trying to decide what to do with it.*

***

"[…] and then after I'm done putting everything in [the washing machine], I realised that there's no detergent, and I'm checking literally everything, but there's no detergent, and I was like, "Oh, that sucks!", so I decided to go outside to get some." – ***P29***

4.2.5.6 Shift

Shift is a deliberate change in goals or methods. It manifests as the participant seemingly jumping from one task to another following a self-disruption of the activity or due to an external distraction. It refers to a change in the focus or direction of an activity, often in response to a disruption, reorientation, or the identification of new possibilities.

Operationally, a shift manifests in our Subcam footage as participants transitioning from one activity or sub-goal. Contrary to a Diversion, participants may or may not return to the initial course of activity or goal pursuit following a shift. We observe participants move from one sub-goal or task to another, often characterised by a ***noticeable change in their focus, behaviour, or the tools or materials they are using***. For example, a participant might be observed putting away cleaning supplies and then moving to a different room to start organising a desk or shelf. During RIWs, we asked participants to describe their thought processes and MDM moments where shifts were observed in the Subcam footage. Participants often provided explanations for why they chose to shift their focus or activity, such as completing a necessary sub-task, responding to a new priority, or adapting to a challenge or opportunity that arose. For example:

> *"I was chopping vegetables, but then I realised I needed to start the rice cooker if I wanted everything to be ready at the same time. So, I rinsed the rice and got it started before going back to the vegetables." **– P40***

> *"I wanted to dust the tables, but I noticed the clutter and cleared them first." **– P18***

> *"Because I heard the notification and saw that she had sent me a message, so I had to reply to them, and that was a decision I made to reply to her messages." **– P44***

> *"I'm quickly going back inside the house here to let [girlfriend] know that I'm going to get detergent." **– P29***

> *"Because when I opened my bag to get out my pencil case, I saw the [note]book [inside the bag], and then I'm like "Okay, I'm just going to take the National History Museum off that [the list] before I continue my drawing". **– P 58***

4.2.5.7 Identify possibilities

Identify Possibilities often follows instances of scan or hesitation through which the participants (re) evaluate the environment and/or situation to identify the possibilities of action and/or affordances. It refers to the process of recognising and considering potential courses of action or solutions in response to a disruption or reorientation in the activity flow. Operationally, identifying possibilities manifests in our Subcam footage as participants ***actively explore and evaluate different options or pathways*** to continue or adapt their activity. In our coding scheme, we identified instances of identifying possibilities by looking for specific indicators in the Subcam footage, RIWs, and RRIWs:

Scanning the environment: Participants visually scan their surroundings, looking for cues, resources, or opportunities that could help them navigate the disruption and reorient themselves towards the goal.

Verbalised consideration of options: Participants explicitly mention or discuss different possible courses of action, often in the form of "I could do this, or I could do that" statements.

Comparative evaluation: Participants weigh the pros and cons of different options, considering factors such as feasibility, efficiency, or personal preference and taste.

During RIWs, participants often described the process of identifying possibilities as evaluating and recognising the alternatives or options. They provided insight into the factors influencing their identification and evaluation of possibilities, such as past experiences, available resources, or situational constraints. For example:

"I realised I didn't have all the ingredients I needed for the Nachos, so I'm checking to see what else there is." – ***P22***

"So, whenever I go grocery shopping, I make a list of things which I need, and I do browse the aisles as well, cuz sometimes when you're making a list, you might not remember that you wanted a certain thing, but then you look at it, and then you remember that's what you wanted. So, it's both making a list and also browsing for something which I might have forgotten when making the list like I already know what I want to buy, but I also browse just to see if I've missed anything." – ***P18***

"I am wearing sports clothes. I'm completely sweaty and dirty anyway, and I'm already cleaning, so there is no reason for me not to. Plus, I have the time as well, right? So, there is no point at all for me to not get this stuff done. So, yeah, I see it [objects that are lying around], I check it out, I realise it's trash, I throw it away" – ***P60***

"No, I'm choosing what I wanted to draw from." – ***P58***

4.2.5.8 Create possibilities

Create Possibilities always follows instances of pause, indicating some degree of creative problem-solving by the participant. The more complex the problem is, the longer the pause seems to be. While pausing, participants create possibilities for the continuation of the activity and (sub)goal pursuit. It refers to the process of generating novel or less experienced options or solutions in response to a disruption and when faced with an expected event or new situation in the activity flow. It often involves a degree of creativity, improvisation, resourcefulness, or problem-solving.

Operationally, creating possibilities manifests in our Subcam footage as participants actively develop new ideas or approaches to navigate the disruption or reorientation, ***going beyond the readily apparent options*** or when there are no apparent solutions, alternatives, or courses of action. In our coding scheme, we identified instances of creating possibilities by looking for specific indicators in the Subcam footage, RIWs, and RRIWs:

Innovative problem-solving: Participants generate novel solutions to the problem at hand, often by combining or adapting existing resources in new ways.

Improvisation and flexibility: Participants demonstrate a willingness to deviate from established plans or routines, improvising new approaches or strategies on the fly.

Resourcefulness and adaptation: Participants make use of available resources and affordances or constraints in creative ways, finding opportunities within limitations to continue or adapt their activity.

During RIWs, participants often described the process of creating possibilities as "figuring out what to do" or "making do with what I have". They provided insight into the cognitive processes and motivations underlying their generation of novel possibilities, such as a desire to overcome obstacles or a need to adapt to changing circumstances and reorient towards the goal. For example:

> *"You'll see me freeze for a good few seconds in a minute because what happened here is I accidentally dropped the glass cleaning liquid in the toilet, and I was thinking what to do. I had no idea what to do, I just froze there and was staring at the toilet. I then decided to take it out and throw it away because it didn't have much left in it anyway, so…" –* ***P29***

4.2.5.9 Continue

Continue is when the participant resumes the initial path after a break in the flow of activity. It refers to the process of progressing with an activity after a period of disruption, reorientation, or the identification or creation of new possibilities.

Operationally, continuing manifests in our Subcam footage as participants ***resume or move forward with their activity*** and goal pursuit, sometimes with a new strategy, plan or course of action.

> *"I can see that at some point, there is no more powder…no more spice coming out. I'm still trying to get it out. I don't give up." –* ***P27***

> *"My sister called me, and I briefly speak with her, she had a question about […], and then I carry on putting away the clothes." –* ***P19***

> *"The goal is still to clear the floors to be able to mop." –* ***P22***

4.2.5.10 Give up (activity abandonment or MDM avoidance)

Give up is ceasing what is currently done. It refers to the discontinuation of an activity, often in response to a significant disruption or a perceived lack of viable possibilities for continuation. We identified two different types of Give up, one being a micro-decision to abandon the activity and the other experiencing avoiding MDM.

Operationally, abandoning manifests in our Subcam footage as participants ***disengage from the activity altogether***. During RIWs and RRIWs, participants often described the decision to abandon an activity or avoid the MDM process as "giving up". They provided insight into the factors influencing their decision to abandon, such as a perceived lack of progress or motivation, insurmountable obstacles, or a reassessment of priorities. They other times explained avoiding any engagement in the MDM process often due to exhaustion or insufficient mental or physical resources (see Give up (activity abandonment vs. mdm avoidance) for details).

> *"I'm giving it a little shot and see if I will be able to clean this off with water, of course I wasn't. So, then I guess like I give up and just put it back."* – ***P56***
>
> *"I don't know where these fluffs come from. It's impossible to stop them, especially since the window is open and there is a draft. I usually try to pick them as I see them floating around, especially when I'm cleaning, but it's no use. It's impossible."* – ***P23***

4.2.5.11 Activity extinction

Activity Extinction concludes the activity cycle when the goal is reached, or the motive is extinct. It refers to the natural conclusion or completion of an activity, often signalled by the achievement of the initial goal or intention.

Operationally, activity extinction manifests in our Subcam footage as participants ***finish their activity***, often accompanied by a ***final evaluation scan before shifting focus, activity and/or location***. During RIWs, participants often described activity extinction as *"finishing up"*, "completing" the task, or *"achieving"* the goal. They provided insight into the cognitive and emotional processes associated with activity extinction, such as a sense of accomplishment, a feeling of closure, or a readiness to move on to the next activity or goal.

> *"I'm happy with the floors now, so the mopping is basically done."* – ***P20***
>
> *"I kind of finished the upstairs. So, now, there is a little bit of a break anyway, which is why I check the emails in the first place, and now I'm dealing with them, I guess."* – ***P22***
>
> *"I think I'm finished with the fridge, so it's job done!"* – ***P48***

The above activity components are what we initially identified in our dataset. While some might appear similar (e.g., fluid flow and continue, and initiation and reorientation), they differ by their position in the course of activity, as they can occur before or after MDM and be experienced differently.

4.2.6 Behavioural Variables

Having explored the key activity components in our model, such as fluid flow, diversion, reorientation, and shift, we now turn our attention to the specific behavioural variables that emerged as we zoomed in on these components and examined how they operationalised in our data. These behavioural variables—pause, hesitation, scan, retry, and give up—were identified through a close analysis of participants' actions and DM processes as captured in the Subcam footage and further elaborated upon through the RIWs and RRIWs. The names of these variables were not arbitrarily chosen by the researchers but rather emerged directly from the language and descriptions used by the participants themselves as they reflected on their experiences during the RIWs.

Moreover, these participant-generated terms served as the basis for the visual cards and cues employed during the RRIWs, allowing participants to engage in a more intuitive and naturalistic process of self-coding as they reviewed their own Subcam footage. By using language and concepts that resonated with participants' own understandings of their actions and MDM processes, we were able to facilitate a deeper and more authentic exploration of the micro-decisional phenomena at play in everyday activities.

Our analysis focuses on five key behavioural events associated with instances of MDM in our data. Below, we explain each operationally, followed by examples from our data. The following link includes examples of the behavioural variables from our dataset: https://shorturl.at/73AZy. Moreover, Figure 16 is an example of our coding sheet, demonstrating how we observed and coded our data.

4.2.6.1 Pause

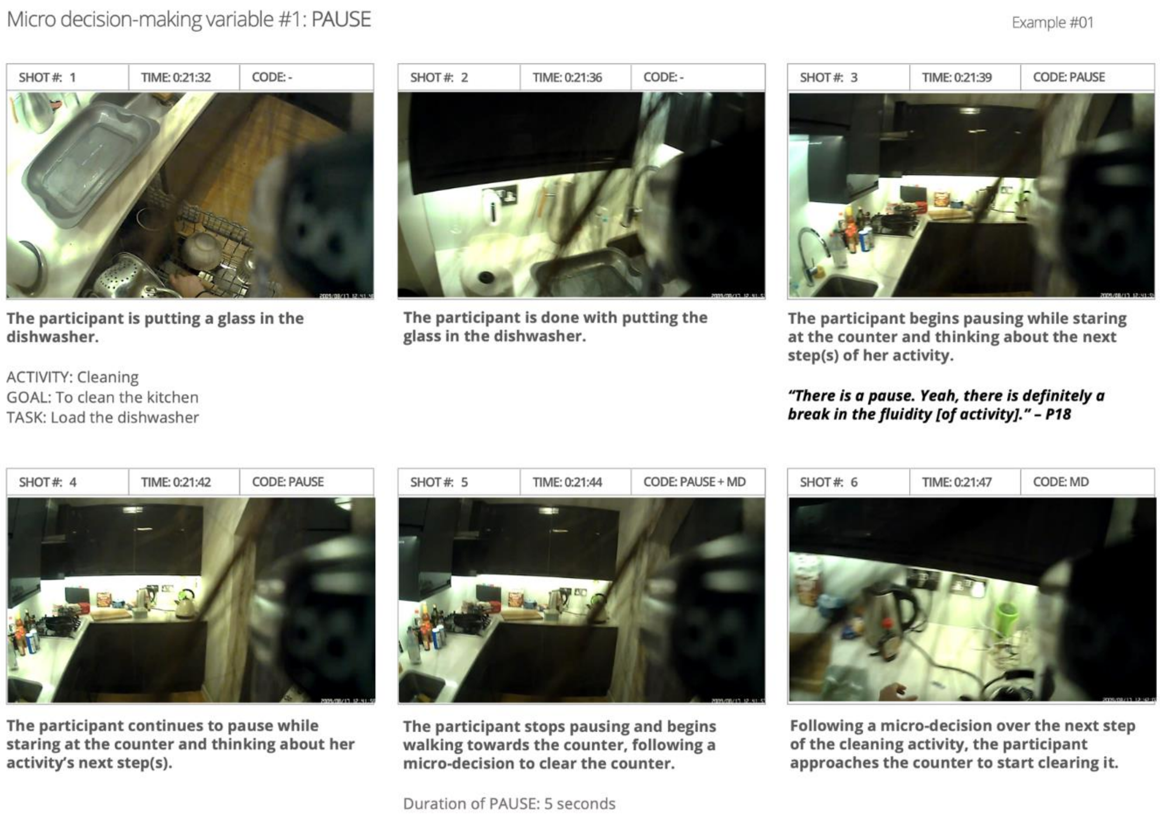
A **Pause** is a temporary stop or break in the flow of activity, which the participant codes as a Pause during the RRIWs. Pausing occurs when the participant freezes or there is an obvious decrease in the speed of activity. A pause typically refers to a temporary stop or break in an action or activity. In the context of DM or task execution, a pause might indicate a moment where the individual stops to think, reflect, or reassess the situation before proceeding.

We see a pause with the current motor action being halted, and the subject does not start another action immediately. A major difference between pause and scan is that we do not see participants moving their heads (scan) or shifting their attention and focus rapidly (hesitation). We also observe sounds and hand gestures, such as tapping, indicating that the participant is thinking. Figure 11 illustrates an example of the pause variable. Participant 18 pauses for 8 seconds, and the fluid flow of her cleaning activity is massively interrupted. She described this situation as:

*"I'm just thinking, and there is a pause. Yeah, there is definitely a break in the fluidity [of activity]. I'm trying to decide what else to do [for cleaning]." **- P18***

Figure 11

An example of Pause from the Subcam footage with the participant's verbatim



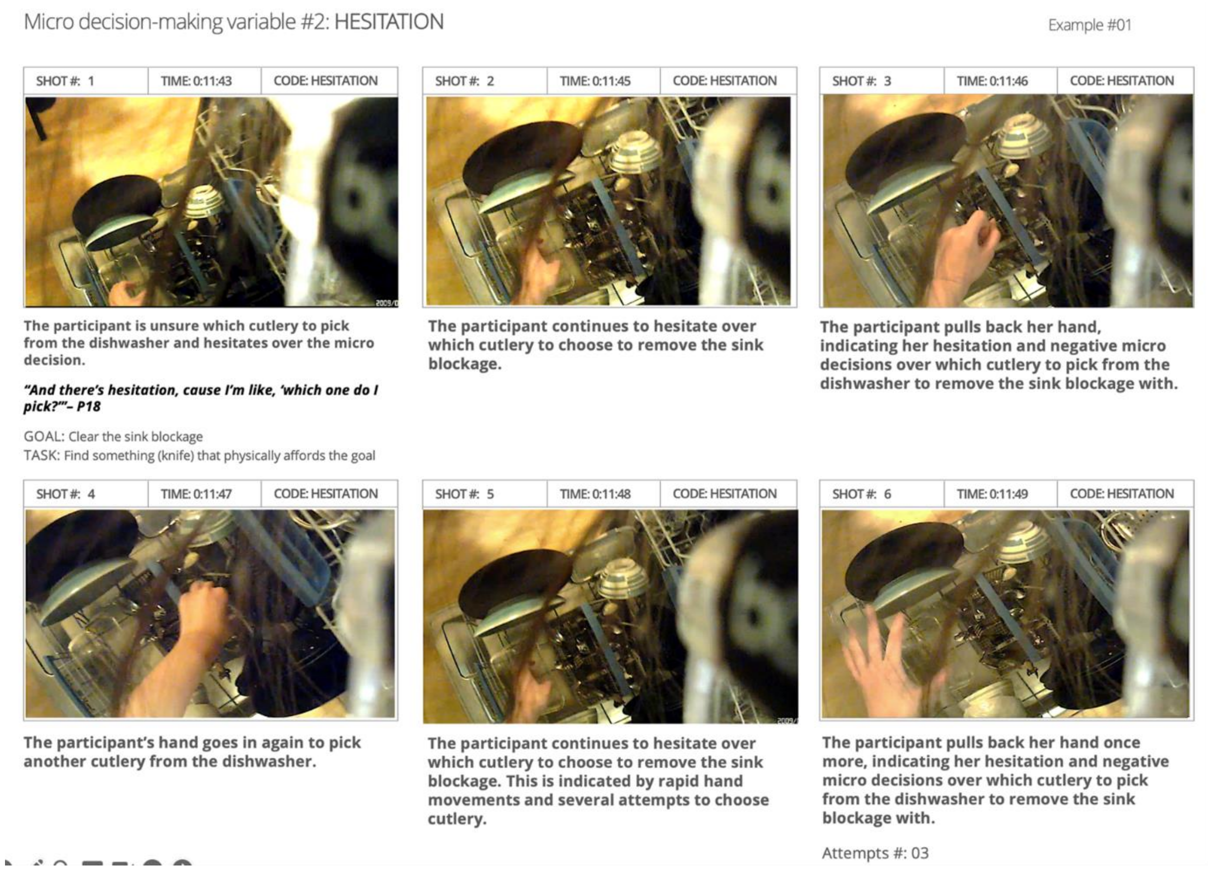
Note. The image includes a series of snapshots from the footage through which the Participant pauses for 5 seconds while cleaning the kitchen.

4.2.6.2 Hesitation

Hesitation is a momentary pause or reluctance before taking action, implying uncertainty or conflicting thoughts. We identify hesitation as instances where the participant appears confused, which is operationalised in our data through rapid head movements and hand gestures indicating a sudden change of mind or uncertainty. A delay or indecision in speech or action often characterises hesitation. It can reflect uncertainty, doubt, or conflict in MDM.

Figure 12

An example of Hesitation from the Subcam footage with the participant's verbatim



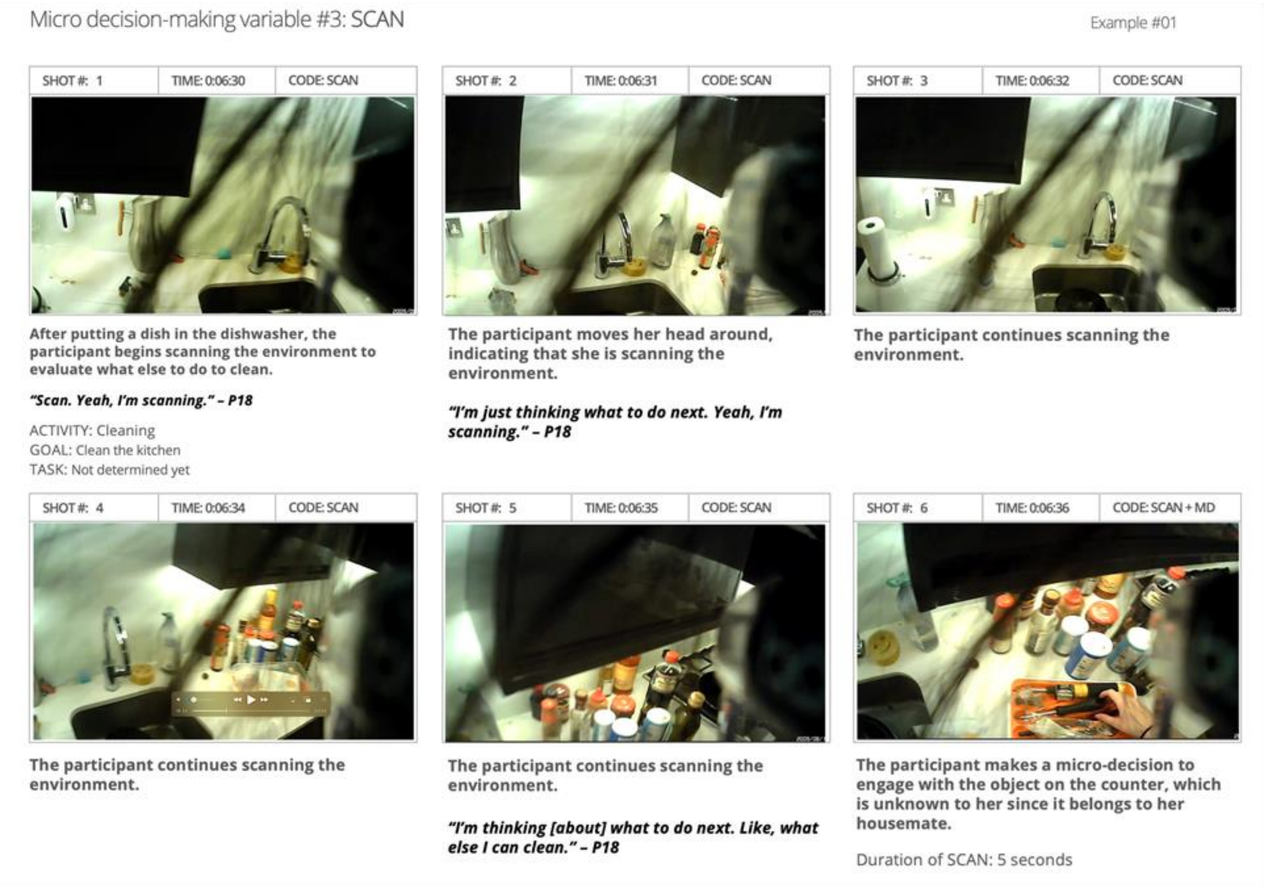
Note. The Participant hesitates over several options. Her hand goes in several times to take cutlery from the dishwasher as she hesitates over which one to take.

4.2.6.3 Scan

Scan is a visual exploration of the environment or options available, manifested in our data, as participants move their heads and look around to evaluate and monitor the environment. This may occur for monitoring purposes or as the participant is orienting themselves towards the goal and looking for the next possible actions or affordances of the environment. Scanning generally involves looking over or reviewing something thoroughly. In the context of DM or task, it might refer to the act of examining or reviewing options, information, or the environment. Scanning can be a part of information gathering, helping an individual to make a more informed decision or understand their situation better. Figure 13 shows P18 as she's looking around to scan the environment, evaluating *"what else there is to clean"* and what would be the next step towards her goal of cleaning the house.

Figure 13

An example of Scan from the Subcam footage with the participant's verbatim



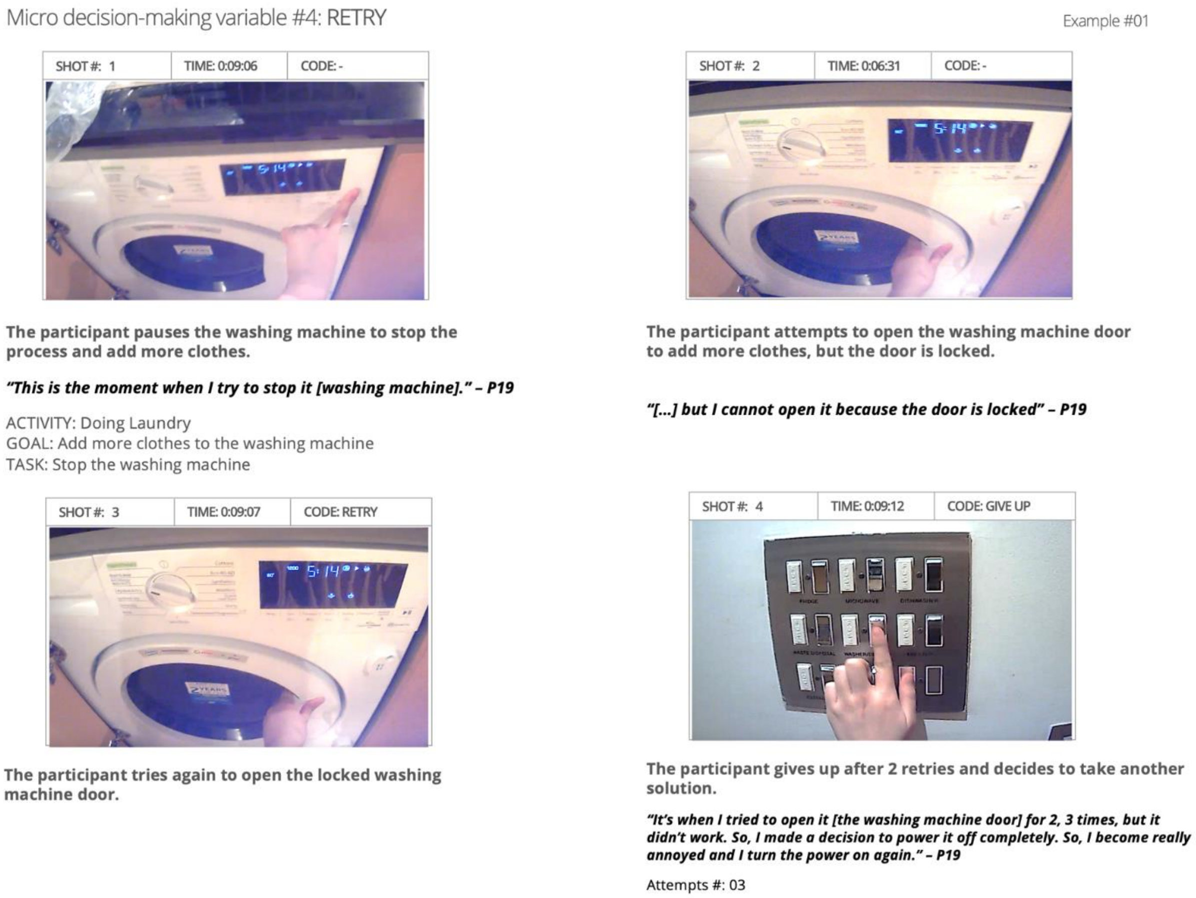
Note. The participant looks around and scans the environment to see what else there is to clean.

4.2.6.4 Retry

Retry is attempting a task or action again after a previous attempt, by repeating the previously unsuccessful action, indicating persistence or a desire to overcome, in the same way, an obstacle in the face of difficulty or initial failure. Our data revealed that retrying is often the first behavioural reaction to a perceived motor problem. Figure 14 shows Participant 19 attempting to open the washing machine and retrying 2 times after failing to open the locked door for the first time, and finally changing strategy after the third failure.

Figure 14

An example of Retry from the Subcam footage with the participant's verbatim



Note. The Participant retries to stop the washing machine two times following a failure of the first attempt.

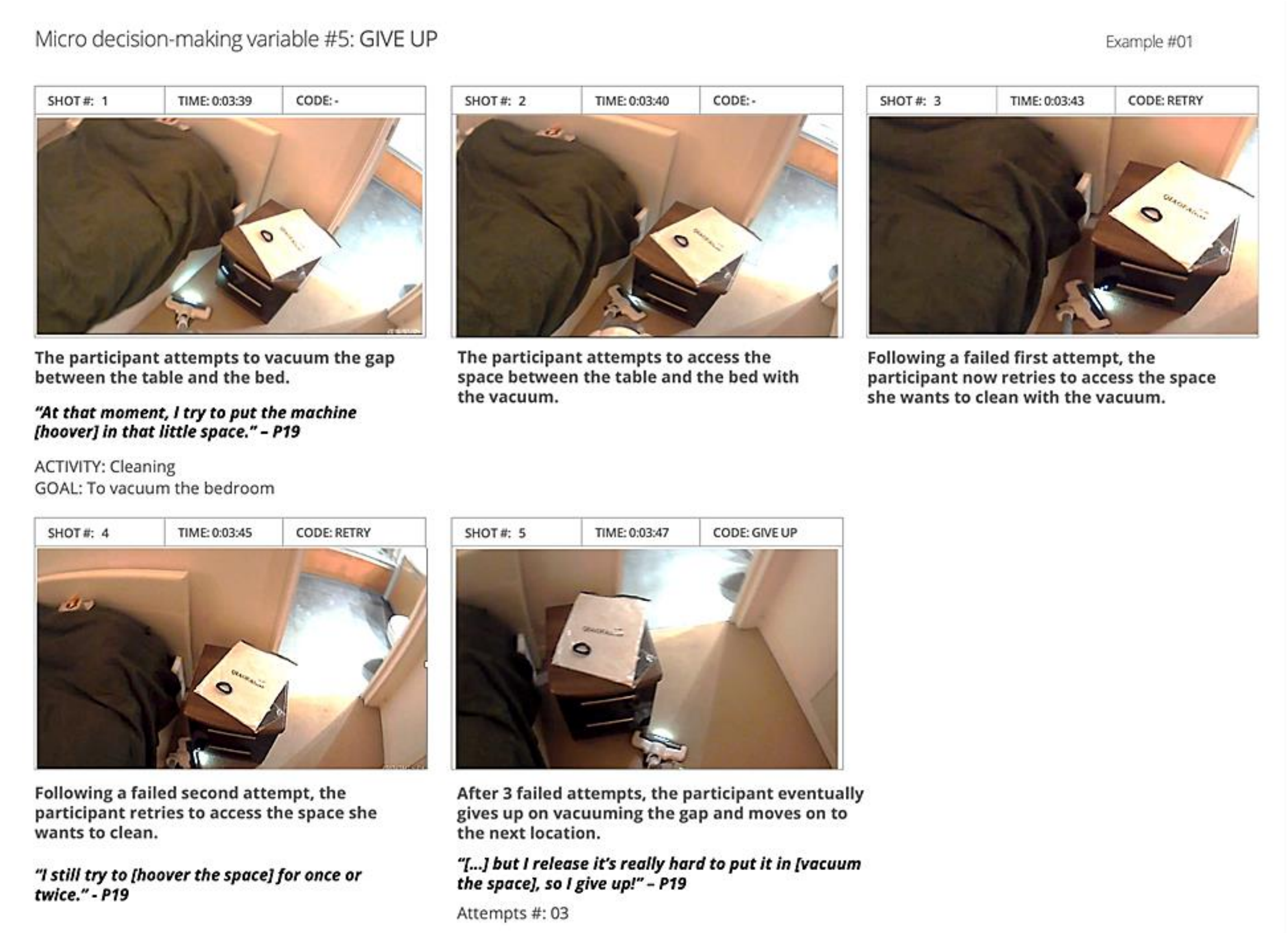
4.2.6.5 Give up

Give up is a code given by participants when they are apparently abandoning or discontinuing an activity, suggesting a reassessment of goals or priorities. In some situations we observe abandonment of the activity or giving up the task and stopping the (sub)goal pursuit prematurely and before the goal is reached or the motive is satisfied. We observe this in our data as a sudden shift in task and abandoning it altogether. An example of giving up is illustrated in Figure 15, in which Participant 19 attempts to hoover a hard-to-access area as she's hoovering the room. Following 2 seconds and 2 instances of retrying, she gives up and moves on to other areas:

> *"I try to get the machine [hoover] to that little space, but I realise it's really hard to [access the area], so I give up!".*

Figure 15

An example of Give up from the Subcam footage with the participant's verbatim



Note. The participant retries to vacuum the hard-to-access area and gives up after three failed attempts.

4.2.7 Sequential Coding

Finally, to gain a deeper understanding of the temporal and sequential patterns of MDM within different activities, we developed a coding scheme to capture the specific sequences of behavioural components surrounding instances of MDM. This scheme built upon the initial coding of behavioural variables (explained above) and aimed to uncover the complex interplay between these variables and the subjective experience of MDM.

The behavioural components sequence coding was conducted in several stages:

1. Identification of MDM instances: Using the data from the RRIWs, we first identified the specific moments within each activity where participants reported experiencing micro-decisions. These instances served as the anchor points for the sequence coding.
2. Coding of preceding and following behavioural components: For each identified MDM instance, we coded the behavioural components that immediately preceded and followed the micro-decision instance. This coding was based on the subcam recordings, RIWs and RRIWs, allowing us to capture the observable behaviours surrounding the subjective experience of MDM.
3. Sequence construction: By combining the coded preceding and following behavioural components, we constructed specific sequences that represented the temporal unfolding of MDM within each activity.
4. Validation and refinement: Coding the behavioural components sequence was an iterative process involving multiple rounds of coding, validation, and refinement. The coding scheme was adjusted based on the insights gained from the data analysis and the feedback from the research team to ensure its reliability and validity. Figure 16 is a sample of our coding sheet demonstrating how we coded our dataset.

The behavioural components sequence coding provided a rich and detailed account of the temporal and sequential patterns of MDM within different activities. By capturing the specific sequences of behavioural components surrounding MDM instances, this coding scheme allowed us to examine the complex interplay between observable behaviours and the subjective experience of DM. The resulting sequence data formed the basis for the analysis of activity component sequences and their relationship to MDM, as discussed in our Research Findings chapter.

Our coding for the following steps (see Figure 16) differs from the initial behavioural coding. While the initial coding focused on observable behaviours, coding for the following steps incorporates elements from our developed model, which emerged from our exploratory and pilot studies. This model includes stages such as 'identify possibilities' and 'shift', which are interpretations of the MDM process rather than strictly observable behaviours. This approach aligns our observational data with the theoretical framework developed throughout the early stages of this research. We acknowledge that this introduces an element of interpretation into our coding process. However, it allows us to track how initial behaviours lead to different stages in our initial model of MDM (see Appendices for a full description of our exploratory and pilot studies). This coding strategy connects our observational data with our theoretical framework, providing a richer understanding of the DM process. We recognise the potential limitations of this approach and have maintained consistency in our interpretations throughout the coding process.

Figure 16

Example extract from the coded data in Microsoft Excel

	Participant	Clip Code	Gend	Ethnic Group	Clip Duration	Activity	Timestamp	Pause	Hesitation	Retry	Give up	Scan	IDK	None	Decision	Duration of I	Retry Success	Self Disruption	Following Steps 1	Following Steps 2	Following Steps 3
327	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:09:33	0	1	0	0	0	0	0	1			0	Continue		
328	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:10:06	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
329	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:10:38	1	0	0	0	0	0	0	1	00:00:07		0	Scan	Create Possibilities	Continue
330	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:11:04	1	0	0	0	0	0	0	1	00:00:03		0	Scan	Create Possibilities	Continue
331	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:11:37	0	0	0	0	0	0	1	0			0	Shift	Continue	
332	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:11:46	0	0	0	0	0	0	1	0			0	Shift	Scan	Continue
333	#27_AOM	#14_AOM	F	Other Ethnic Group		Cooking	00:14:29	1	0	0	0	0	0	0	1	00:00:05		0	Scan	Create Possibilities	Continue
334	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:15:00	0	1	0	0	0	0	0	1			1	Scan	Continue	
335	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:16:50	0	0	0	0	0	0	1	0			0	Shift	Hesitation	Continue
336	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:17:21	1	0	0	0	0	0	0	1	00:00:01		0	Scan	Create Possibilities	Continue
337	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:17:31	0	1	0	0	0	0	0	1			0	Scan	Give up	Continue
338	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:17:40	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
339	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:17:44	0	0	0	0	0	0	1	0			0	Shift	Continue	
340	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:19:01	1	0	0	0	0	0	0	1	00:00:01		0	Scan	Create Possibilities	Continue
341	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:19:05	1	0	0	0	0	0	0	1	00:00:01		0	Scan	Identify Possibilities	Activity Initiation
342	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:19:19	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
343	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:19:45	0	0	0	0	0	0	1	0			0	Shift		
344	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:20:34	0	0	0	0	0	0	1	1			0	Shift		
345	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:20:43	1	0	0	0	0	0	0	1	00:00:06		0	Scan	Create Possibilities	Continue
346	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:22:09	0	0	0	0	0	0	1	0			0	Shift	Continue	
347	#27_AOM	#14_AOM	F	Other Ethnic Group		Misc.	00:22:29	0	0	0	0	1	0	0	1			1	Identify Possibilities	Activity Initiation	
348	#61_TS	#15_TS	F	Other Ethnic Grou	00:13:21	Cleaning	00:01:28	0	1	0	0	0	0	0	1			0	Scan	Identify Possibilities	Continue
349	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:01:35	0	1	0	0	0	0	0	1			0	Scan	Continue	
350	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:02:26	0	1	0	0	0	0	0	1			1	Shift	Continue	
351	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:03:30	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
352	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:03:38	0	0	0	0	1	0	0	1			0	Continue		
353	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:03:46	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
354	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:05:07	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
355	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:07:44	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
356	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:10:06	0	0	0	0	1	0	0	1			0	Identify Possibilities	Continue	
357	#61_TS	#15_TS	F	Other Ethnic Group		Cleaning	00:10:13	0	1	0	0	0	0	0	1			0	Scan	Identify Possibilities	Continue

4.2.8 Data Analyses

We analysed the collected data using a combination of qualitative and quantitative methods. As said above, participants were interviewed using RIWs, during which they reviewed their footage and provided detailed explanations and reflections on their subjective experiences, thought processes, and DM moments.

Coding was done using the RRIW protocol developed and tested during pilot studies (see Appendix F). In RRIWs, participants used the card-based coding system to identify instances of breaches in the fluidity of their activity and select the appropriate card to describe their subjective experience. This step aimed to reduce researcher bias and capture participants' subjective experiences more accurately.

The RIW data were analysed using Thematic Analysis (TA) to identify common patterns, themes, and categories related to the subjective experience of MDM. Moreover, our quantitative analysis of the coding (from the RRIW and TA) involved using descriptive statistics to summarise the prevalence and distribution of different types of breaches in the fluidity of activity and the proportion of these breaches associated with different behaviours and subjective micro-decisions.

Finally, we did a final round of coding to observe the sequences and their identified components (shift, continue, etc.) Through this final round of additional coding, we observed and analysed sequences of behaviours following a breach of the flow (e.g. pause, scan, continue). Through such analyses, we identified various types of activity models that occurred in our and reported the most frequently observed types.

4.2.9 Reliability Tests

Intercoder reliability, also known as inter-rater reliability, measures the agreement between different coders/observers in a study. It is essential in qualitative research to ensure that the coding of behaviours or events is consistent across different individuals. According to Lombard, Snyder-Duch, and Bracken (2002), intercoder reliability is crucial for demonstrating the objectivity of interpretations made by researchers, particularly in content analysis. They assert that without established reliability, content analysis measures are more subjective, limiting the study's reproducibility and validity. Similarly, Krippendorff (2008) emphasises the importance of reliability in content analysis, suggesting that it is a prerequisite for making claims of knowledge.

To ensure the reliability and validity of our coding scheme, we conducted a series of coding procedures and comparisons involving the main researcher (Researcher 1: Oraee) and two additional researchers (Researcher 2: Hauter and Researcher 3: Liu). This multi-step approach allowed us to assess the consistency of the coding scheme when applied by different researchers and to evaluate the compatibility between researcher coding and the participants' own coding of their subjective experiences. Considering that we conducted RRIWs with a subsample of 51 participants out of a total of 60, below, we have summarised and named the various codings and samples for clarification purposes before reporting the coding procedure and compatibility scores.

Participant Samples:

- S1: Participants who wore the Subcam and did a RIW (N=60)
- S2: Participants who wore the subcam did a RIW and a RRIW (this is a subsample of S1) (N=51)

Coding Sets:

- Set A: Breaks coded by Researcher 1 on the basis of Subcam footage only (for all participants in S1)
- Set B: Breaks coded by participants with RRIW (for all participants in S2)
- Researcher 1: Conducted Set A. Coding was compared to Set B, and test results are reported below.
- Researcher 2: Coded a proportion (see below) of S2 on the basis of Subcam footage and codebook only. Coding was compared to Set B, and test results are reported below.
- Researcher 3: Coded a proportion (see below) of S2 on the basis of Subcam footage and codebook only. Coding was compared to Set B, and test results are reported below.

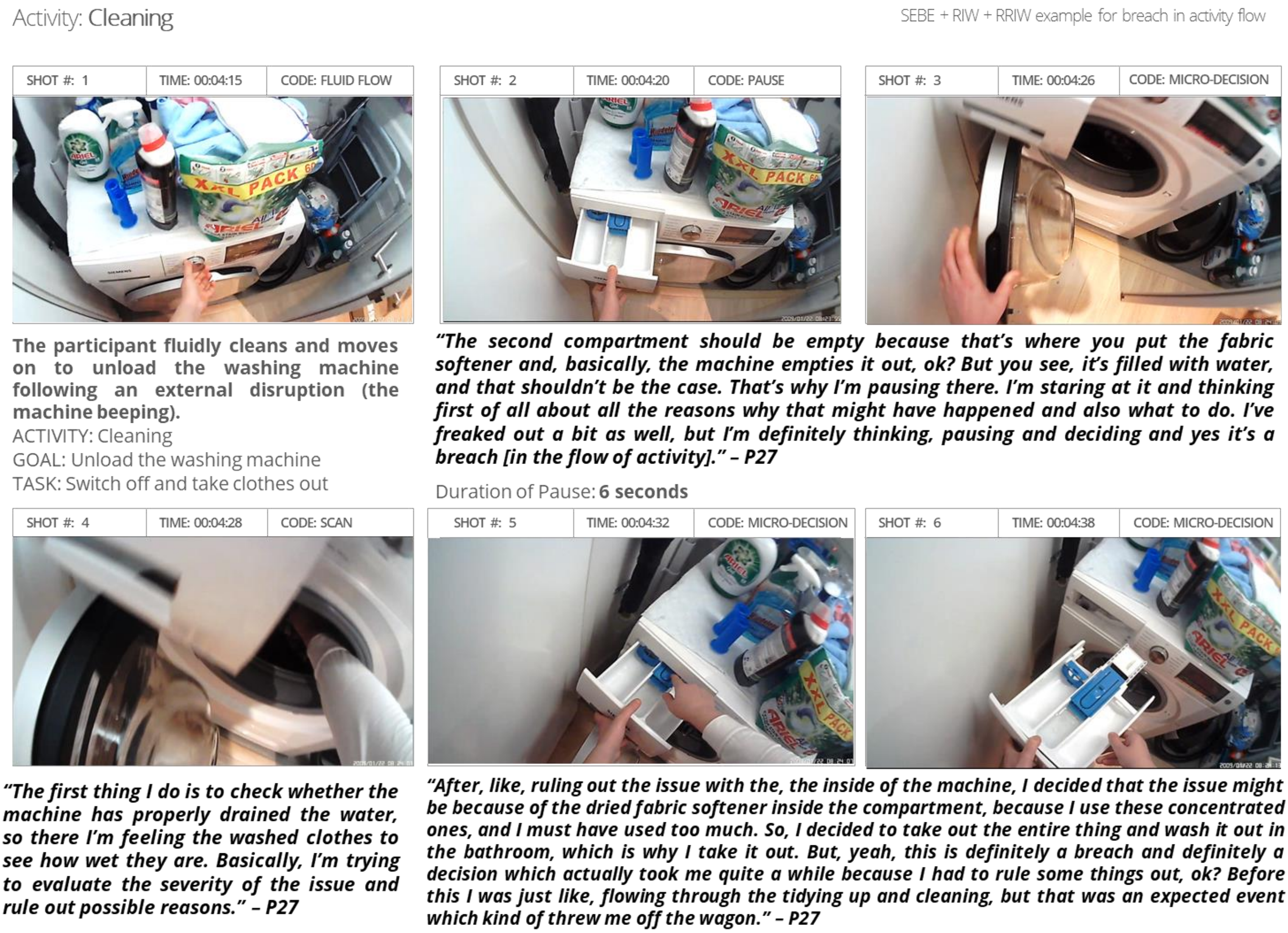
Coding Procedure:

- **Step 1:** Researcher 1 coded the entire Subcam footage (57 hours, 56 minutes, and 06 seconds: Set A) using the codebook developed during the pilot studies. The codebook contained specific behavioural occurrences, such as pause, hesitation, retry, give up, and scan. It also incorporated whether the participant experienced a break in the flow of activity as a micro-decision (from the RIW: “is this a decision”).

- **Step 2:** Researcher 1 compared 49 hours, 9 minutes, and 20 seconds of the total Subcam footage of Set A and Set B (representing 84.89% of the total footage); therefore, the subcam footage that was reviewed during both RIWs and RRIWs was nearly 85% of the total subcam footage gathered from 60 participants. Thus, Set B consists of 85% of Set A with the participant codings obtained through the RRIW sessions. During these sessions, participants used visual cues to identify and code instances of MDM and their subjective experiences. What was coded are all the observable breaches of the flow (pauses, retries, etc.): 2726 behavioural events. The figure below is an example which demonstrates the coding of a single breach in the flow of activity during a cleaning task, specifically unloading a washing machine. The participant is cleaning their apartment and is externally disrupted by the beeping of the washing machine, indicating that the cycle is done. The flow of activity is then disrupted by an unexpected event which leads to a 6-second pause while the participant is evaluating the problem and deciding over the next steps. Crucially, this entire sequence is counted as one breach in the activity flow, not as multiple separate events. This example clarifies that when we refer to 2726 behavioural events, we're not counting each individual action (like multiple retries) as separate events. Instead, each breach in the flow of activity - in this case, the pause when noticing the issue with the fabric softener compartment - is counted as one event, regardless of the number of subsequent actions or decisions it triggers.
- The compatibility percentage between Researcher 1's coding and the RRIW participant coding was 88%, with a Cohen's Kappa of 0.76, indicating a substantial level of agreement. In other words, this step included comparing Set A from S1 to Set B from S2 and showed that the coding by the researcher with the classic SEBE technique (subcam + RIW) is 88% identical to the RRIW coding by the participant.

Figure 17

Example of what we coded as a breach in the flow of activity



Step 3: To assess the reliability of the coding scheme, Researcher 2 and Researcher 3 were given only the Subcam footage and the codebook to code *independently*. The purpose was to compare the researchers' coding based *solely on the Subcam footage* (no RIW)with the participants' coding of their own footage obtained through the RRIW sessions. Researchers 2 and 3 only used the Subcam footage, so they had less information than Researcher 1 in the other tests, which made the tests tougher.

What percentage of the codes is agreed upon between different researchers based only on the behavioural data (the subfilm)? And how does the researcher's coding match the subject's interpretation of their own behaviour? The results below are reassuring on the reliability of the coding.

Proportion of Data Coded and Compatibility Scores:

- Researcher 1 coded the entire Subcam footage (57 hours, 56 minutes, and 06 seconds), representing 100% of the total footage in the study.
- The comparison between Researcher 1's coding and the RRIW participant coding was conducted for 49 hours, 9 minutes, and 20 seconds of the total Subcam footage (representing nearly 85% of the total footage), resulting in an 88% compatibility and Cohen's Kappa of 0.76. These scores are from comparing the events that Researcher 1 coded with RIW with the events that the participants coded themselves during the RRIWs.
- Researcher 2 coded 4 hours, 32 minutes, and 37 seconds of the Subcam footage, representing approximately 7.86% of the total footage.
- The compatibility percentage between Researcher 2's coding (based solely on the Subcam footage) and the RRIW participant coding was 85.66%, with a Cohen's Kappa of 0.80, indicating a high level of agreement.
- Researcher 3 coded 4 hours, 19 minutes, and 31 seconds of the Subcam footage, representing approximately 7.45% of the total footage.
- The compatibility percentage between Researcher 3's coding (based solely on the Subcam footage) and the RRIW participant coding was 80.70%, with a Cohen's Kappa of 0.74, indicating a high level of agreement.

The table below summarises the intercoder Reliability and compatibility scores for the multi-step coding procedure.

Table 3

Intercoder Reliability and Compatibility Scores for the Multi-Step Coding Procedure

Step	Researcher	Coding Procedure	Proportion of Data Coded	Compatibility Scores
1	Researcher 1	Coded entire Subcam footage using codebook	100% (3211 events) (57 hours, 56 minutes, 06 seconds)	-
2	Researcher 1	Refined 85% of initial coding based on RRIW participant coding	84.89% (2726 events) (49 hours, 9 minutes, 20 seconds)	88% compatibility with RRIW participant coding (Cohen's Kappa: 0.76)
3	Researcher 2	Independently coded a portion of Subcam footage using the same codebook	7.86% (279 events) (4 hours, 32 minutes, 37 seconds)	85.7% compatibility with Researcher 1's refined coding (Cohen's Kappa: 0.80)
4	Researcher 3	Independently coded a portion of Subcam footage using the same codebook	7.45% (342 events) (4 hours, 19 minutes, 31 seconds)	80.7% compatibility with Researcher 1's refined coding (Cohen's Kappa: 0.74)

The multi-step coding procedure we employed serves several important purposes:

1. By having Researcher 1 code the entire Subcam footage and then refine 85% of their coding based on the RRIW participant coding, we ensured that the final coding scheme accurately captured the participants' subjective experiences and perspectives, enhancing the study's validity.
2. The 88% compatibility between Researcher 1's subcam footage coding (3211 coded breaks in the flow of activity throughout 57 hours, 56 minutes, 06 seconds of subcam footage) and the RRIW participant coding (2726 coded breaks in the flow of activity throughout the matching 49 hours, 9 minutes, and 20 seconds of subcam footage)

demonstrates a high level of agreement between researcher coding and participant self-coding, further validating the coding scheme.

3. Researcher 2 and Researcher 3 independently coded a portion of the Subcam footage, and the subsequent high intercoder reliability scores (Cohen's Kappa of 0.809 and 0.743, respectively) demonstrate that our coding scheme was reliable and can be consistently applied by different researchers.

In conclusion, the coding procedures and comparisons we employed demonstrate our coding scheme's robustness and validity while incorporating the participants' subjective experiences through the RRIW method. The high levels of agreement and compatibility obtained through these tests provide a solid foundation for interpreting and discussing our findings, ultimately strengthening the credibility and impact of our research.

Conducting research that involves collecting and analysing personal data, such as video footage and subjective experiences, raises important ethical considerations that must be addressed to protect participants' rights and well-being. In the next subsection, we explain the ethical issues we considered for our research.

4.3 RESEARCH STAGES OF THE MAIN STUDY

Following our exploratory and pilot studies (see Appendix E and Appendix F for a full report), we conducted our main study through the following stages:

1. **Data Collection:**
   - Recruited a diverse sample of 60 UK adults aged between 22 and 60 using purposive sampling, ensuring a balance in gender and ethnic/cultural group representation.
   - Collected 57 hours, 56 minutes, and 06 seconds of first-person perspective digital ethnographic data using subcams, capturing participants' everyday activities and MDM processes. On average, approximately 57 minutes and 56 seconds of Subcam footage was collected per participant.
   - Conducted RIWs with all 60 participants (sample S1), totalling more than 40 hours, with approximately 45 minutes of RIW per participant to review the footage and gather in-depth insights into their subjective experiences.
   - Conducted RRIWs with 51 out of the 60 participants (sample S2, a subset of S1) with an average of approximately 37 minutes per participant. 49 hours, 9

minutes, and 20 seconds of the total subcam footage (85% of the entire subcam dataset) were reviewed through RIWs and RRIWs together.

- In total, we collected 147 hours, 5 minutes, and 26 seconds of SEBE data (subcam footage + RIWs + RRIWs) and analysed in this study. This includes 79 hours, 28 minutes, and 56 seconds of confrontation data (RIW + RRIW), which we collected and analysed throughout our research.

2. **Data Analysis and Findings:**
    - Analysed the data from Set A of Sample 1, identifying 3211 breaks in the flow of activity (i.e., the activity flow was breached every 1 minute and 5 seconds on average). These breaks are instances when the activity is disrupted. In other words, these are instances where (confirmed with participants) the flow of activity is massively breached, and the participants reorient or abandon the activity prematurely. It is important to note that not all interruptions in activity flow led to experiences of MDM. For example, retrying an action multiple times does not equate to multiple counted breaks. Only instances where the activity flow was significantly disrupted and acknowledged by participants as such were coded and counted as breaks. In this dataset (S1) 2435 (75.83%) instances of micro-decision out of the total breaches in the flow of activity.
    - From Set B from sample Sample 2, we counted 2726 breaks in the activity flow. These breaks were counted, coded, and confirmed by the participants as micro-decisions during the RRIWs. It is important to note that not all interruptions in activity flow led to experiences of MDM. For example, retrying an action multiple times does not equate to multiple counted breaks. Only instances where the activity flow was significantly disrupted and acknowledged by participants as such were coded and counted as breaks. Therefore, three retries to resume flow without engaging in MDM count as a single break, not three. Additionally, while not all instances of giving up were classified as decisions, those that were coded as such represented clear breaks in the activity. We confirmed 2302 (84.47%) of the total breaks in the activity flow as micro-decisions with the participants.
    - Observed and coded 5 behavioural events which we found connected with MDM experiences: Pause, Hesitation, Scan, Retry, and Give Up, which were found to be associated with instances of MDM. This analysis was done on the whole corpus collected from sample S1.

- Conducted statistical analyses to evaluate the relationship between activity type and the behavioural variables and instances of MDM. Developed a basic activity model based on the concepts of fluid flow, diversion, disruption, and orientation, which was iteratively refined through the analysis of the main data collection and RRIWs.

3. **Reliability Tests:**
   - Researcher 1 coded the entire subcam footage from sample S1 using the codebook developed during the pilot studies (Set A) and compared their coding to participant coding (Set B) on insights gained from RRIWs. The compatibility percentage between Set A (from S1) and Set B (from S2) was 88%, with a Cohen's Kappa of 0.76.
   - To assess the reliability of the coding scheme, Researcher 2 and Researcher 3 independently coded a portion of the subcam footage using the same codebook as Researcher 1.
   - Intercoder reliability tests between Set Researcher 2's coding and participant RRIW coding (Set B), as well as between Researcher 3's coding and Set B, yielded high levels of agreement, with Cohen's Kappa values of 0.80 and 0.74, and compatibility percentages of 85.66% and 80.70%, respectively.
4. **Integration and Theory Development:**
   - Integrated the findings from the exploratory stage, pilot studies, main data collection, and reliability tests to develop a comprehensive understanding of MDM in everyday life.
   - Proposed non-linear activity models based on the statistical analyses of the activity processes observed and also based on the concepts of fluid flow, diversion, disruption, and orientation, which provided a theoretical framework for understanding the subjective experience of MDM.
   - Discussed (see Towards a non-linear model of MDM) the non-linear activity models in light of the reviewed literature, followed by the implications of the findings for understanding MDM in everyday life.
   - Finally, we highlighted the research's contributions to the field of DM and its potential for future research and practical applications.

4.4 ETHICAL CONSIDERATIONS

The methodology we employed for our research required providing candid explanations of the decision's rationale and accepting some degree of transparency. The general guidelines of SEBE were followed, which ensured that ethical issues were monitored and addressed during the process (Lahlou, 2011; Lahlou et al., 2015). This ensured, among other things, that if the participant engaged in (and records inadvertently) behaviours that might be risky to disclose, they (or the researcher if the participant does not realise the sensitive nature of the material) had ample opportunity to discard it from the research. The high ethical standards of research at LSE were an important concern, and the SEBE guidelines were discussed in detail with the LSE ethical board when the method was applied to adolescents (Everri, 2017). These ethical reflections were grounded in a systematic review of potential incidents and risks in 198 films (117.1 hours of video recording) made with the SEBE protocol. They nourished the SEBE ethical guidelines and, more generally, the good practice for using video in ethnography, as published by the LSE team (Everri et al., 2020).

For example, as a part of the method, participants were given the opportunity to review and edit any footage they did not want to share before the data was given to the researcher (the participants record their activity at home, and the footage is recorded on micro-SD cards that the participants can view before the researchers). Furthermore, participants were provided with an information sheet to understand why the research was being done and what it involved. This was followed by an informed consent form, which the research participant completed. Applying the SEBE guidelines not only facilitated the research as the protocols and ethical procedures were already tested and validated, but also ensured that a high ethical standard was upheld.

Indeed, besides discussions with research ethics committees, which is the cornerstone of any research ethics process, the "ethical twist" for visual research is to consider those involved as participants in the research rather than subjects of observation or as informers. That "participatory twist" improves the quality of data collected through the trust obtained by transparency and participation. It also helps to solve the complex (and often emergent) issues arising from the disclosure of specific behaviours to other public, with the informed help of the involved "natives", in the most culturally adapted way (Everri et al., 2020).

Risk can often be dealt with by raising awareness, taking simple precautions, and adopting quick interventions when issues emerge. Thus, a risk analysis was conducted for the proposed research; rather than trying to completely avoid risks, which is futile, relevant precautions were taken to prevent them, followed by preparations for rare cases in which something does happen.

1. At an operational level, a generic (but comprehensive) guide for the researcher to build the research ethical guidelines has been adapted, including procedures and cases for their ethics committee (see Table 4). The "solutions" summarised in Table 4 have emerged from researchers' experiences, negotiations, mistakes and coping strategies and will be adapted with regard to the local contexts in which they take place. Having a transparent discussion with participants on the actual motives of the research, on how it will be used, and addressing the potential problems candidly is the best way forward for ethical as well as heuristic reasons. For this reason, participants were provided with an information sheet (see Participant information sheet) to understand why the research is being done and what it will involve. This was complemented by an informed consent form, which the research participant completed.
2. Finally, in terms of the data management plan, we took the following steps: The research project generated the following types of data: a. Video recordings: First-person perspective video data captured using SEBE methodology (Subfilms and film replay interviews). b. Interview transcripts: Transcribed data from RIWs and RRIWs. c. Coded data: Data generated from the coding of video recordings and interview transcripts using the RRIW and RRIW techniques. d. Participant information: Demographic data and participant consent forms.
3. Data Format, Storage, and Backup

   a. Video recordings were stored in MP4 format on a secure, password-protected hard drive and server.

   b. Interview transcripts were stored as text files (.docx, .txt) on the same secure hard drive and server.

   c. Coded data was stored in a spreadsheet format (.xlsx) and as text files on the secure server.

   d. Participant information was stored separately as text files and in a spreadsheet format on the secure server.

   e. All data was backed up regularly on a separate, secure server to prevent data loss.

4. Metadata, Documentation, and Sharing

a. Video recordings, interview transcripts, and coded data were labelled with participant ID, date, and relevant details.

b. Coded data was accompanied by a codebook describing variables, categories, and definitions.

c. Access to raw data was restricted to the researcher and supervisor.

d. Coded data, with personal identifiers removed, may be shared with other researchers upon request and after signing a data-sharing agreement.

e. Aggregated and anonymised findings may be shared through publications, presentations, and public data repositories.

5. Ethical Considerations, Privacy, and Long-term Preservation

   a. Participants were informed about the research purpose, data collection process, and their rights through an informed consent procedure (see Appendix for the Participant Information Sheet).

   b. Personal identifiers were removed from the data during coding and analysis to ensure participant privacy and confidentiality.

   c. After the research project's completion, selected data (e.g., coded data and aggregated findings) will be preserved for long-term storage and future use in a trusted digital repository.

6. Responsibilities and Resources

   a. The researcher was responsible for data collection, coding, analysis, storage, and quality assurance.

   c. As the hosting institution, LSE provided necessary resources, such as secure servers, data backup systems, and technical support.

This data management plan was regularly reviewed and updated throughout the research to ensure its relevance and effectiveness in supporting the study goals and research data integrity. In practice, no issue emerged in our data collection process, and the participants did not feel the need to edit their recordings. This is not so surprising after all since most everyday tasks are not risky nor ethically sensitive.

Table 4

Problems and proposed solutions for video research ethics[2]

Problems/ critical issues	Description	Proposed solutions
Researcher-researched rapport	Video research methods blur researcher-researched boundaries > Power imbalances > Ethical issues on rapport	Before commencing the study: Apply contextual judgement Practice reflexivity: consider multiple stakeholders' perspectives Consider participants as "research collaborators" Pilot study including some data analysis discussion with participants
Informed consent	Collection of video recordings is rarely pre-defined > Emergence of new data from recordings in the field > Ethical issues on dominant "a priori bio-medical" informed consent protocols	Negotiate/renew consent at different stages of the research Involve children and parents in consent negotiations (when children are research participants) Use video-recorded verbal consent from third-parties (cast)
Participants' rights	Videos challenge participants' privacy > Provide vivid details > Easy to share > Ethical issues on anonymity, confidentiality, ownership, and release of data	Use data management plans: Details participants' rights and duties Be open to negotiate to reach a balance between participants' protection and usability of the material for scientific scopes Make explicit arrangements in the consent forms

[2] Adapted from Everri, M., Heitmayer, M., Yamin-Slotkus, P., & Lahlou, S. (2020). Ethical challenges of using video for qualitative research and ethnography. State of the art and guidelines. In T. Lähdesmäki, E. Koskinen-Koivisto, V. L. A. Čeginskas, & A.-K. Koistinen (Eds.), *Challenges and Solutions in Ethnographic Research. Ethnography with a Twist* (pp. 68–83). Routledge. https://doi.org/10.4324/9780429355608

In the following chapter, we present the findings of our research, detailing the results of our analysis of the data collected using the SEBE and RRIW protocol. Our findings are structured into several key sections:

First, we provide an overview of our empirical findings, including the frequency and distribution of micro-decisions across various everyday activities. We then explore the behavioural indicators associated with MDM, with a particular focus on the “Retry” and “Give up” behaviours that emerged as significant in our analysis.

Next, we examine the relationship between different types of activities and the occurrence of micro-decisions, providing insights into how context influences DM processes. We also delve into the various components of activity and their association with MDM, offering a nuanced understanding of how decisions unfold within the flow of everyday tasks.

The chapter concludes with a synthesis of our core findings, integrating our observations on MDM with the theoretical frameworks discussed in our literature review. This synthesis aims to provide a comprehensive view of MDM in naturalistic settings, setting the stage for the discussion that follows in the subsequent chapter.

5 RESEARCH FINDINGS

Our detailed initial analysis of the activity components revealed that MDM is not subjectively experienced as occurring through two (or more) reified thought processing systems but rather is experienced, more or less explicitly, according to how regulated and fluid an activity process is as we pursue our daily goals. The activity is experienced as an unproblematic flow that sometimes requires reorientation when this flow is breached. The regulation of the flow, as well as the breaches, occur through the physical environment, the actor's psychological state, and the social setting. In other words, experiences of MDM are significantly dependent on the activity ecology, including the ever-changing context, which until very recently has been off limits due to extreme methodological difficulties. Decision does not appear as an isolated process but rather as a means to an end, a step in a larger process of goal-directed, motivated activity. Therefore, the decision is highly dependent upon the motives and the conditions given.

We divided our findings chapter into three sub-sections, delving into the empirical, methodological and theoretical aspects of the research findings, respectively.

5.1 TYPES OF ACTIVITY

We collected 57 hours, 56 minutes, and 6 seconds of digital ethnographic data (subfilms) from a diverse group of N=60 UK adults aged between 22 and 60. This equated to an average of 57 minutes and 56 seconds of data per participant, ensuring a robust and representative dataset.

We analysed the subfilms with the participants through nearly 80 hours of RIWs and RRIWs combined. More than an hour was spent with each participant to review the recorded footage. The RIWs were conducted with all 60 participants (sample S1), while the RRIWs were conducted with a subset of 51 participants of the initial recruited 60 (sub-sample S2).

The footage contained typical everyday mundane activities such as cleaning, cooking, rearranging items such as groceries, commuting, doing laundry, washing up, etc. These activities usually involve inconsequential micro-decisions.

We processed the subfilm dataset of 57 hours, 56 minutes, and 6 seconds to provide a clear overview of the time allocation across different activities. The total duration for each recorded activity was calculated by summing the time spent on individual subcam recordings. These durations were then converted into proportions of the total recorded time of subfilms, offering insights into how participants divided their time among various everyday tasks. We focused on everyday mundane activities, which typically include inconsequential micro-decisions.

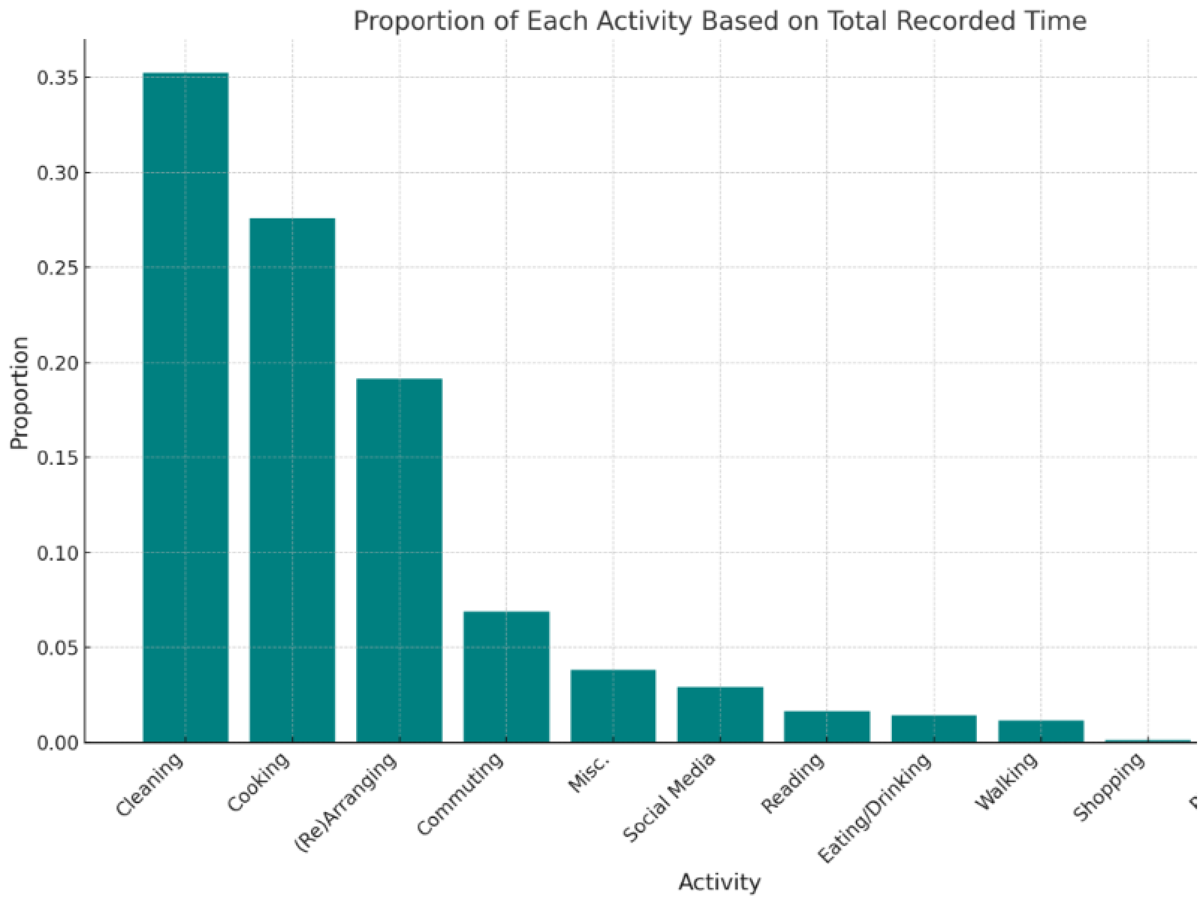
The analysis revealed the following proportions of time spent on each activity:

- **Cleaning**: 35.26%
- **Cooking**: 27.60%
- **(Re)Arranging:** 19.14%
- **Commuting:** 6.91%
- **Miscellaneous:** 3.83%
- **Social Media:** 2.92%
- **Reading**: 1.65%
- **Walking**: 1.14%
- **Eating/Drinking:** 1.43%
- **Shopping:** 0.12%

The dataset shows a significant portion of time is dedicated to **Cleaning**, **Cooking**, and **(Re)Arranging**, which together account for over 80% of the total recorded time. Cleaning activity includes a wide range of tasks such as washing up, mopping, hoovering, (un)loading the dishwasher, dusting, etc. Cooking includes any task related to preparing a meal or drink, and (Re)Arranging is any task that involves any kind of organising and arranging or rearranging items, such as after grocery shopping or organising the kitchen, putting away the clothes, or packing items. Activities such as **Commuting** and **Miscellaneous tasks** also represent a notable share. Commuting involves footage from participants commuting via the tube, bike and bus. Miscellaneous tasks involve activities such as playing games on the phone, playing an instrument, watching something, talking on the phone, taking a COVID-19 test, etc. Lower proportions are observed in engaging with **Social Media**, **Reading**, and **Walking**, which reflect less frequent engagement with these activities in the dataset's context. Finally, the smallest proportions are seen in **Eating/Drinking** and Grocery **Shopping**. The figure below illustrates the recorded everyday activities in order of their prevalence in our dataset.

Figure 18

Recorded everyday activities in order of most to least prominent in the dataset



To ensure the highest level of validity and reliability, we focus our analysis on the data for which we were able to conduct the entire protocol, including RRIWs. We, therefore, present the statistics of activity breaks, micro-decisions, and behavioural variables based only on the data collected using the final protocol, which consists of SEBE, RIWs and RRIWs. While we initially collected a total of 57 hours, 49 minutes, and 42 seconds of subcam footage from 60 participants, we were only able to conduct further RRIWs with 51 participants due to the inaccessibility of some participants. As a result, our counts of breaks, micro-decisions (confirmed by participants) and behavioural variables are based on the data from these 51 participants, which amounts to 49 hours, 9 minutes, and 20 seconds of Subcam footage, representing almost 85% of the total collected subfilms.

In our analysis, we focused on identifying and quantifying the breaks in the flow of activity and the occurrence of micro-decisions within these breaks. Additionally, we examined the prevalence of the behavioural variables (pause, hesitation, scan, retry, and give up) and their relationship to the identified micro-decisions. By concentrating on the data for which we have the complete protocol, including the invaluable RRIW data, we ensure that our findings are grounded in the participants' own interpretations and validations of their subjective experiences. This approach allows us to draw more robust and reliable conclusions about the nature of MDM in everyday life.

To ensure the accuracy and reliability of our empirical findings, we focused on the Set B dataset from sample S2 when calculating the number of breaks in the flow of activity, micro-decisions, and behavioural variables. This dataset consisted of 49 hours, 9 minutes, and 20 seconds of footage from the 51 participants who completed both RIWs and RRIWs and was analysed jointly with the participant throughout nearly 80 hours of confrontation interview sessions (RRIW + RRIW). In total, we counted on this complete data set with RRIW 2726 breaks in the flow of activity as participants engaged in their everyday mundane tasks. Breaks in the flow were identified as instances where the fluid activity was halted. It is usually observable by an interruption of action that signals some issue: the participant does not know what to do, or something is blocking the action, some object is missing, etc. These breaches were rather easily identified by the coders (who are the participants themselves and the researchers).

To be clear, there are 2726 activity breaks in the final dataset. These breaks are instances when the activity is disrupted. In other words, these are instances where (confirmed with participants) the flow of activity is massively breached, and the participants reorient or abandon the activity prematurely. As for give up and retry, only instances were coded in the datasheet when the activity flow was disrupted, but the disruption did not all lead to experiences of MDM (e.g. when retrying or avoiding MDM). Only instances where activity flow was broken were coded and counted. If there are successive behaviours in the same break, it counts as one. For example, 3 successive retries don't mean 3 breaks; the sequence is counted as one break, and then the participant may resume flow without even having to make a micro-decision or engage in problem seizing or solving. As for give-ups, they were not all decisions, but nevertheless, the ones we coded were breaks in the activity. Each row in the Excel file is one break. As soon as a break was noticed, a row was added to the datasheet. The next step was to see which behaviour this break manifests as (pause, scan, etc.) and then whether this break was experienced as a decision or not. As we'll see below, slightly more than 84% of the breaks were coded by participants as related with subjective experiences of MDM.

One purpose of this research was precisely to identify what causes these breaks, how the subjects react to them, and their connection with the processes of orientation and micro-decision. So, in the sample, the fluid flow of activity was interrupted 2726 times, on average every 1 minute and 5 seconds. Below is an example from Participant 48 when their otherwise fluid flow of cooking activity was interrupted.

Figure 19

An example of Disruption from the Subcam footage with the participant's verbatim

Note. The participant fluidly cooks a meal by the stove and then approaches the fridge to get some ingredients, but their activity is disrupted, and the flow is breached once they are faced with the options in the fridge. They explain the thought process.

Then, it seems some specific instances of orientation towards the goal require more subjective decisions from the participant. Intersections throughout the activity process where the flow of the activity is seriously breached and thus disrupted require thinking, rerouting, and reorienting while trying to figure out the following action(s). P19 expressed such breaches in the otherwise fluid flow of activity as *"definitely a break in the fluidity [of activity]"*. Empirically, we can identify such situations through behavioural variables: pause, hesitation, and scan. In other words, the reorientation process manifested in our data as pausing, hesitation, or looking around to scan the environment.

From the total counted breaks in the activity in sample S2, 2302 (84.47%) of them were counted, coded, and confirmed by the participant as micro-decisions. It must be clear that our criterion here was subjective (the participants themselves call these "decisions"), so a micro-decision is defined as "what the subjects themselves call a decision" throughout our research. This is obtained by systematically asking the participant: "Did you experience this instance as making a decision"?

So, in our sample, participants made a micro-decision every 1 minute and 17 seconds as they engaged in their everyday lives, and slightly more than 84% of the 2726 breaches in the flow that were spotted were connected to a micro-decision. We have explained our entire coding procedure and concepts in the section on our coding and concepts starting from page 59 of the thesis.

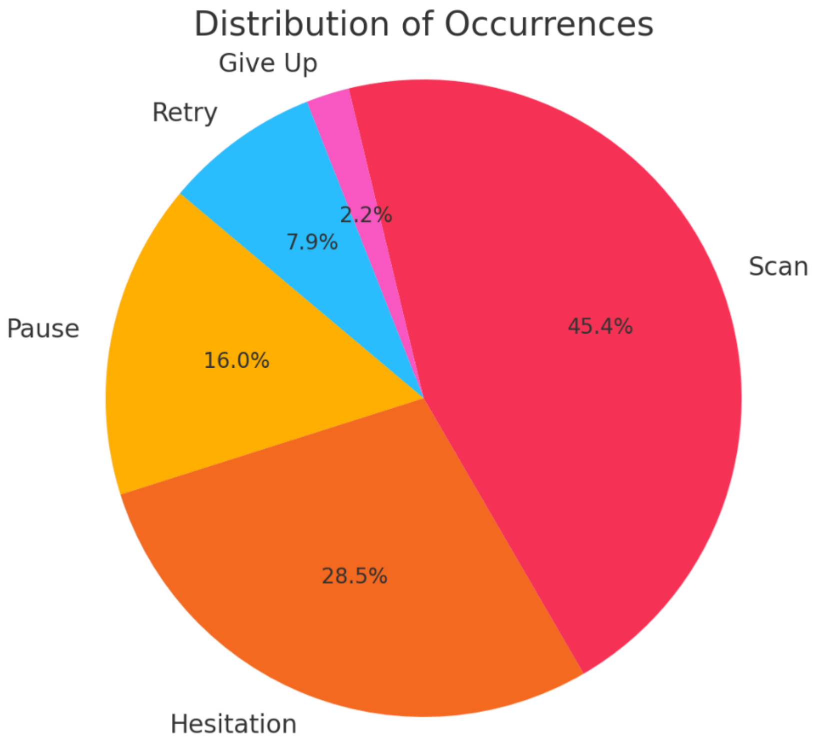
In the following subsection, we delve into the analysis of the behavioural variables (pause, hesitation, scan, retry, and give up) that emerged as behavioural indicators of MDM in our data. By exploring the frequency and distribution of these variables, as well as their co-occurrence with micro-decisions, we aim to shed light on the subtle yet crucial role these behaviours play in the MDM process.

5.2 BEHAVIOURAL EVENTS AND MDM

The analysis of behaviours based on a dataset of 2726 instances of a break in the activity revealed important insights into the frequency of specific behaviours and their connection to micro-decisions. The behavioural events we observed and examined include Pause, Hesitation, Scan, Give Up, and Retry (see 4.1.5. Coding and Concepts for descriptions and examples). The most frequent behavioural occurrences were Scan (45.4%, 1238 occurrences) and Hesitation (28.5%, 777 occurrences), followed by Pause (16.0%, 436 occurrences), Retry (7.9%, 215 occurrences), and Give Up (2.2%, 60 occurrences). Pauses lasted 4 seconds on average. Overall, we coded 30 minutes and 48 seconds of pause in our dataset. The figure below illustrates the frequency of the behavioural variables.

Figure 20

Distribution of behavioural occurrences from the total breaks in the flow of activity



The table below illustrates the proportion of each variable that led to a micro-decision and how many of each were confirmed with the participant as a micro-decision during the RRIWs. It compares the total counts of each variable, the counts of each variable that was connected to a micro-decision, and the percentage. Pause was connected to micro-decisions 97.45% of the time, Hesitation 94.52%, and Scan 88.23%, indicating a strong correlation between these behaviours and micro-decisions.

In contrast, Give Up and Retry showed significantly lower connections to micro-decisions, with only 31.03% and 15.02%, respectively. This analysis shows that while Scan, Hesitation, and Pause are not only frequent but also highly likely to be connected and correlated with micro-decisions, behaviours such as Give Up, and Retry are less frequently connected with experiences of making a micro-decision. This was somewhat surprising and will be discussed in the discussion section. These findings provide valuable insights into the dynamics of MDM and the significance of our identified behavioural variables in making micro-decisions throughout everyday activities.

Table 5

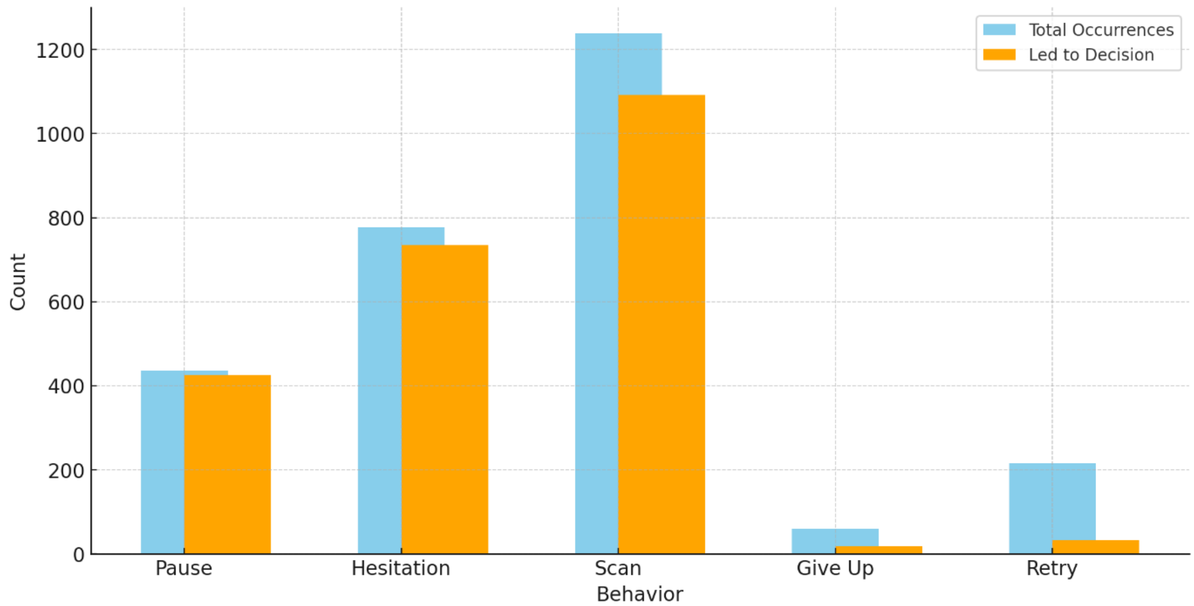
Various behaviours and their connection to micro-decisions

Behavioral Variable	Total Occurrences	Connected with Micro-Decision	Percentage Connected with Micro-Decision
Pause	436	425	97.45%
Hesitation	777	734	94.52%
Scan	1238	1092	88.23%
Give Up	60	19	31.03%
Retry	215	32	15.02%

Similarly, the following bar chart (Figure 21) shows how often each behaviour is connected to a micro-decision. It visually represents the relationship between the total occurrences of specific behaviours and how often these behaviours were connected to micro-decisions. The chart uses two bars for each behaviour: one representing the total occurrences (in light blue) and the other representing the occurrences that led to a micro-decision (in orange). The visual distinction between the light blue and orange bars effectively highlights the differences in how each behaviour correlates with micro-decisions. As noted above, the chart clearly shows that certain behaviours are much more likely to be associated with micro-decisions than others. Pause, Hesitation, and Scan have high percentages of leading to micro-decisions, indicating a strong correlation with experiences of making a micro-decision. In contrast, Give Up and Retry are less frequent and less likely to be connected with micro-decisions.

Figure 21

Comparison of total occurrences and instances connected with micro-decisions for each behaviour



Pause and Hesitation both have very high proportions of connection with micro-decisions, indicating these are critical moments where micro-decisions are frequently made and reorientation is taking place. Considering Retry, it occurs less frequently and is accompanied by micro-decisions much less often than the others, supporting the idea that MDM processes are less involved in retry, which is more of an automatic move without further consideration and attempt to continue without making a deep assessment of why the flow was stopped. Give Up, despite its low total count, shows a moderate percentage of decisions, which appears at first sight bizarre since one would assume that it is, per se, a decision. We will discuss this in more detail in the discussion section.

We conducted a logistic regression beyond the proportion tests to delve deeper into the relationships between behavioural variables and experiences of MDM occurrence. This method allowed us to assess the likelihood of micro-decisions given the presence of one or more behavioural variables. The logistic regression provided insights into the impact of each variable while controlling for the influence of others, and it offers coefficients that can be interpreted as the odds ratio for micro-decisions given a behavioural variable. Following the successful fitting of our logistic regression model, the results for the model’s coefficients and significance were as follows:

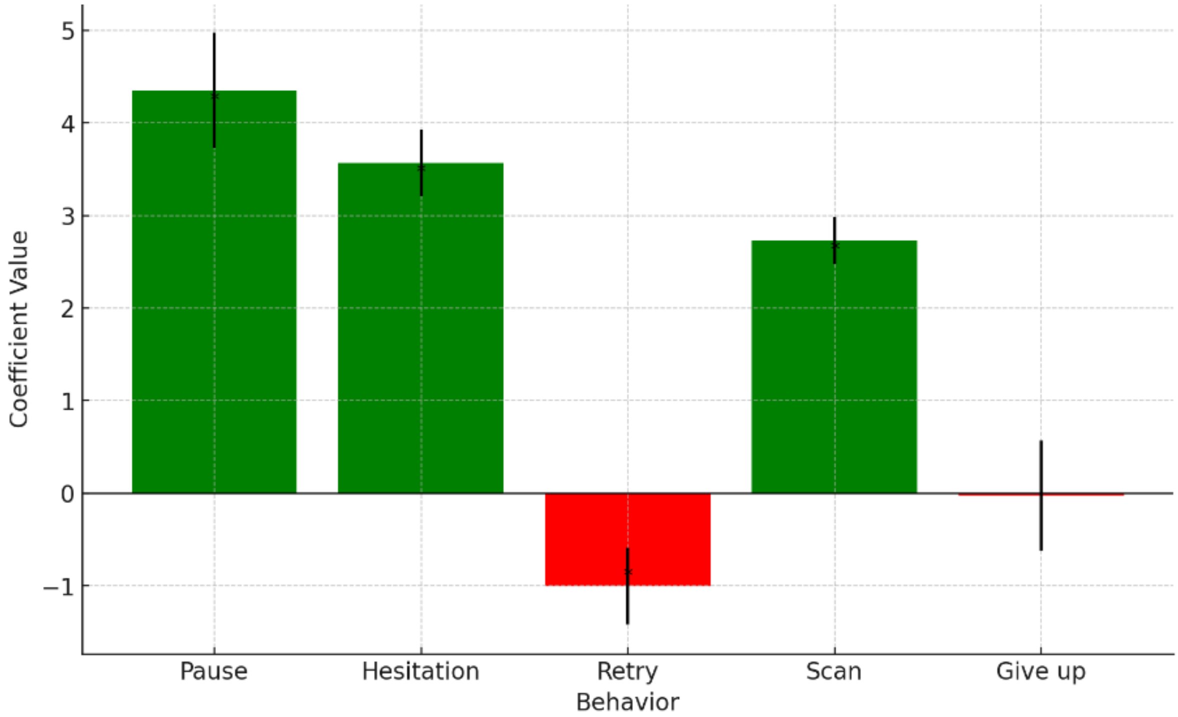
- **Pause**: Coefficient = 4.349, p-value < 0.001
- **Hesitation**: Coefficient = 3.569, p-value < 0.001
- **Retry**: Coefficient = -1.005, p-value < 0.001
- **Scan**: Coefficient = 2.731, p-value < 0.001
- **Give Up**: Coefficient = -0.025, p-value = 0.936

Our model's pseudo R-squared is 0.371, suggesting a reasonable fit to the data. These behavioural variables explain about 37% of the variability in experiences of making micro-decisions. Moreover, the log-likelihood and LLR p-value indicate that the model as a whole significantly improves the fit over an intercept-only model.

To effectively visualise the results of the logistic regression analysis, the below bar chart (Figure 21) displays the coefficients of each behavioural variable. This allows us to easily compare the impact of each variable on the likelihood of MDM. Positive coefficients are shown above the zero line, indicating an increase in the likelihood of a micro-decision when the behaviour occurs, while negative coefficients are displayed below the line, indicating a decrease.

Figure 22

Regression coefficients of behaviours on experiences of making a micro-decision



Pause, Hesitation, and Scan have positive coefficients and are highly significant. The positive coefficients imply a positive relationship; as these behaviours occur, the likelihood of a micro-decision being taken by the participant increases. Retry has a negative coefficient that is statistically significant, indicating that when Retry occurs, the likelihood of the participant experiencing making any micro-decisions actually decreases. Give Up shows a very small, statistically insignificant negative coefficient, suggesting that there is no connection between what we coded as give up and experiences of MDM.

The logistic regression analysis confirms that while Pause, Hesitation, and Scan are reliable indicators of situations that are connected to MDM by the participants, Retry and Give Up may represent distinct processes that do not necessarily involve the same level of deliberative MDM.

The negative coefficient for Retry and the statistically insignificant coefficient for Give Up raise intriguing questions about the nature of these behaviours and their relationship to MDM. To better understand these findings, we will delve deeper into the Retry and Give Up behaviours towards the end of this chapter (see sections Retry and MDM and Give up (activity abandonment vs. mdm avoidance), treating them as peculiar instances that warrant further investigation.

Building upon these insights, we now turn our attention to the role of activity type in MDM. While our analysis of behavioural variables has provided valuable insights into unravelling MDM, it is important to consider how these processes may be influenced by the broader context of the activities in which they are embedded. In the following subsection, we will explore how different types of activities, such as cleaning, cooking, and commuting, and these contextual factors may interact with MDM in everyday life.

5.3 ACTIVITY AND MDM

We conducted a detailed analysis of the activity proportions within our dataset that recorded various everyday activities alongside associated metadata such as clip duration and the micro-decisions made during these activities. The primary aim was to understand the distribution of activities and their relative frequencies. We then explored the distribution of micro-decisions across the recorded activities. To statistically analyse whether there's a meaningful correlation between activity and experiences of MDM, we conducted a chi-square test of independence. This test determined if the distribution of micro-decisions across activities is different from what would be expected if there was no association between them.

The chi-square test gives us a statistic of approximately 46.34 with a very low p-value of about 1.24×10^{-6}. This indicates that there is a statistically significant association between activity type and MDM. Such a result means that MDM does vary significantly across different activities, supporting the idea that the context provided by the activity affects MDM experiences. This result suggests that certain activities might be more likely to involve MDM than others, and this difference is significant rather than due to random chance.

Essentially, we analysed the occurrences of our behavioural variables across various activities. To make the data comparable across activities with different recorded durations in our Subcam footage, we normalised the counts of each behavioural variable by the total number of breaks in the activity flow. Table 6 shows both the raw counts and the normalised percentages, allowing us to compare the behavioural events across different activities. Values marked as "N/A" indicate that either no instances of the corresponding behaviours were observed for that particular activity or the number of observations was too low to conduct meaningful analyses.

Pauses are notably frequent in Social Media (24%) and Miscellaneous activities (21%), suggesting that these activities are often disrupted and require reorientation. In contrast, activities like Walking show no pauses, indicating a more continuous flow without frequent disruptions.

Hesitation is most prominent in Cooking (33%) and (Re)Arranging (30%), reflecting the need for reorientations in these activities to identify and choose among affordances. Conversely, activities like Miscellaneous (17%) and Walking (20%) show lower hesitation rates.

Scanning is particularly high in Walking (80%) and Commuting (60%), global motor activities that require constant environmental awareness and assessment. In contrast, Reading (43%) has a lower scanning rate, likely because the focus is confined to the text.

Retry rates are generally low across all activities, with the highest in Cleaning (13%) and Miscellaneous (12.5%). Activities like Social Media, Shopping, Walking, and Reading show no retries, indicating a smoother flow of action without the need to repeat motor actions.

In our dataset, the frequency of giving up is highest in Eating/Drinking (4%) and Shopping (3%). Activities such as Walking and Reading show no instances of giving up, suggesting these activities are more straightforward or engaging enough to see through to completion or to the point that satisfaction is reached (e.g., when going on a walk for a short break or casually reading a book to spend some time).

Micro-decision rates are notably high across most activities in our study. Shopping (94%), Social Media (90%), and Miscellaneous activities (90%) exhibit the highest rates of micro-decisions. These figures suggest that these activities frequently involve MDM experiences and demand active cognitive engagement, often requiring participants to reorient themselves within the task.

It's crucial to note that our “Miscellaneous” category encompasses a variety of activities that were less frequently captured in our subfilms. This category includes activities such as watching something, playing games, ordering food online, and performing everyday administrative tasks like paying bills or booking tickets. We also observed instances of participants engaging in puzzle-solving or playing games on their phones within this category.

The high micro-decision rate in the Miscellaneous category can be attributed to the diverse nature of activities it contains. Many of these activities, particularly administrative tasks and mind games, inherently involve frequent DM. For instance, when paying bills, one might need to decide which bills to pay first, how much to pay, or which payment method to use. Similarly, games and puzzles often require a series of quick decisions.

Given the cognitive demands of these varied activities, the high rate of micro-decisions in the Miscellaneous category aligns with our expectations. This highlights the pervasive nature of MDM across a wide range of everyday activities, even those that might seem routine or recreational at first glance.

Even activities with the lowest micro-decision rates, such as Commuting (70%) and Cleaning (78 Table 6: Event Frequency and Normalised Percentages%), still show a high proportion of breaks in the flow of activity that are connected with experiences of making micro-decisions.

From this analysis, we realise that different activities impose varying cognitive demands and elicit distinct patterns of MDM and behavioural variables. High pause rates in Social Media suggest that this activity more frequently requires cognitive effort to reorient and make micro-decisions. High scanning rates in Walking and Commuting highlight the need for environmental awareness in these activities. Low give-up rates across most activities suggest that individuals generally pursue a continuous flow in their actions.

In the tables below, we've added a "Breach in the Activity Flow (Total)" row to show the denominator for each activity. For example, for Cleaning activities, there were 120 instances of Pause out of a total of 929 breaks we coded as participants engaged in these activities.

To account for the different durations and frequency of activities, the counts were normalised. Each count was divided by the total number of activity breaks for that specific activity, then multiplied by 100 to convert it into a percentage. The second table presents these normalised figures, making them comparable across different activities. For example, if there were 59 instances of scanning during commuting and a total of 98 breaches in the activity flow for commuting, the normalised percentage for scanning in commuting would be (59 / 98) * 100 ≈ 60%. Cells with values of 0 or 100 were replaced with 'N/A' to indicate that these values could not be reliably calculated due to either the absence of data or insufficient duration of the activity. This allows for meaningful comparisons and highlights the unique cognitive and behavioural demands of each activity. For instance, high pause rates in Social Media and Miscellaneous activities suggest frequent interruptions, while high scan rates in Walking and Commuting indicate continuous environmental monitoring.

Not all breaks coincide with micro-decisions. The micro-decision rate for each activity is calculated by dividing the total number of confirmed micro-decisions by the total number of breaks in the activity. This gives us the proportion of breaks that involved subjective experiences of making a micro-decision. The micro-decision rate differences across activities reflect the varying cognitive demands and complexities associated with each task. High micro-decision rates indicate activities that are cognitively intensive and require continuous engagement, and where breaks are "problems requiring a decision", while lower rates suggest more routine, less demanding tasks, where the breaks can be overcome without a decision. In sum, these tables highlight the context-dependent nature of MDM and activity as an ideal starting point when aiming to understand and change MDM in everyday life.

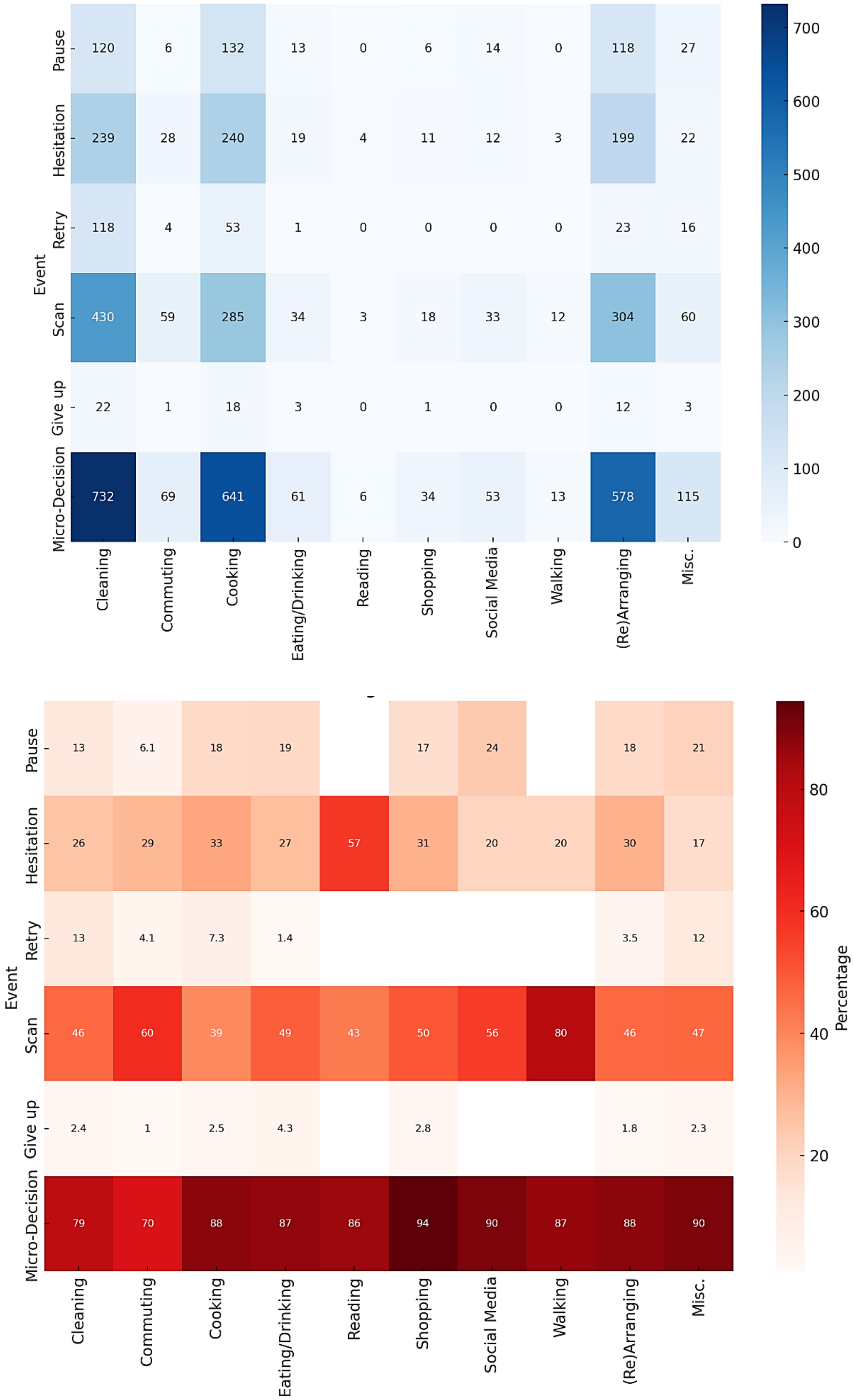
Figure 23 displays a comparative analysis of behavioural events across various activities. The first heatmap illustrates the frequency of events such as pauses, hesitations, retries, scans, giving up, and micro-decisions in activities like cleaning, commuting, cooking, etc. Darker shades in this heatmap signify higher counts considering the total breaches that occurred throughout that activity, indicating that certain events occur more frequently in specific activities. For instance, scanning is highly frequent in cleaning activities. The second heatmap presents a normalised view, showing the percentage of each event relative to the total breaches in activity flow for each activity. Darker shades here represent higher percentages, highlighting the prevalence of each event within the context of overall activity disruptions. For example, the high percentage of scanning in commuting reveals its significant impact on commuting activities. This illustration provides a more convenient identification of the relative prevalence of different behaviours and micro-decisions across our recorded daily activities.

Table 6 *Event frequency (top) and normalised percentages (bottom) across activities*

Event	Cleaning	Commuting	Cooking	Eating/Drinking	Reading	Shopping	Social Media	Walking	(Re)Arranging	Misc.	Total
Pause	120	6	132	13	0	6	14	0	118	27	436
Hesitation	239	28	240	19	4	11	12	3	199	22	777
Retry	118	4	53	1	0	0	0	0	23	16	215
Scan	430	59	285	34	3	18	33	12	304	60	1238
Give up	22	1	18	3	0	1	0	0	12	3	60
Breach in the Activity Flow (Total)	929	98	728	70	7	36	59	15	656	128	2726
Micro-Decision	732	69	641	61	6	34	53	13	578	115	2302
Event	**Cleaning**	**Commuting**	**Cooking**	**Eating/Drinking**	**Reading**	**Shopping**	**Social Media**	**Walking**	**(Re)Arranging**	**Misc.**	
Pause	13	6	18	19	N/A	17	24	N/A	18	21	
Hesitation	26	29	33	27	57	31	20	20	30	17	
Retry	13	4.08	7.28	1.43	N/A	N/A	N/A	N/A	3.51	12.5	
Scan	46	60	39	49	43	50	56	80	46	47	
Give up	2	1	2	4	N/A	3	N/A	N/A	2	2	
Breach in the Activity Flow (Total)	100	100	100	100	100	100	100	100	100	100	
Micro-Decision	79	70	88	87	86	94	89	87	88	90	

Figure 23

Raw count of event frequency (top) and normalised percentages (bottom) across activities



In sum, our analysis of the relationship between activity type and MDM revealed that the nature and demands of different everyday activities significantly influence the prevalence of experiences of MDM. The chi-square test of independence confirms a statistically significant association between activity type and micro-decisions, indicating that certain activities are more likely to involve MDM than others. By normalising the counts of behavioural variables across activities, we have identified distinct patterns in the occurrence of pauses, hesitations, scans, retries, and give-ups, which reflect the unique cognitive demands and challenges of each activity. For example, the high pause rates when participants are on social media suggest frequent disruptions and reorientation instances, while the high scanning rates in Walking and Commuting highlight the need for constant environmental awareness. Moreover, the varying rates of MDM across activities, with Reading, Shopping, and (Re)Arranging showing the highest decision rates, underscore the context-dependent nature of MDM in everyday life.

These findings provide a solid foundation for understanding how the broader context of an activity shapes MDM and that micro-decisions cannot, and should not, be isolated from the context of activity when investigated. In the following subsection, we will delve deeper into the analysis of activity component sequences and their relationship to MDM. By examining the temporal and sequential patterns of behavioural components and micro-decision instances within each activity, we aim to uncover the complex interplay between the structure of activity and the subjective experience of MDM and to identify more frequent patterns.

5.4 ACTIVITY COMPONENTS AND MDM

Upon analysing the relationship between the nature of the activity and MDM, we then explored the behavioural variables and components to gain a temporal understanding of MDM and identify any patterns that might emerge. To achieve this, we coded what behaviour follows the instances coded as breaks in the fluidity of activity in light of our developed model. We coded up to 3 stages of behaviour, which follow the coded behavioural variables. A complete codebook and descriptions of our codes and components, followed by examples from our coding sheet, can be viewed in section 4.2.5. Coding and Concepts. To analyse our data, we processed the data to build sequences to enable further analyses and visualisation. The ten most frequent sequences we observed in our dataset are as follows:

1. **Scan => Identify Possibilities =>Micro-decision => Continue** (626 occurrences)

   *"I didn't know what to do with that bowl. I was making the decision to, like, clean it so that it can be recycled or, should I just throw it away so, right now, I'm like, "hmmm", so I'm looking at the bottom and sides to see if there are any signs and I'm trying to decide what to do with it." – **P55***

   *"By walking near where the chocolate is I got reminded that I needed some. Yeah, and then, like, I went to another alley [aisle], which is about, sort of, gluten-free things, and I finally found the one [granola] he [roommate] wanted. Oh, and then by being in this alley [aisle], I saw this vegan sauce, and I was like, "Oh, why not try them?". So, this time, I didn't think from before that I needed that sauce, but I just saw it and why not?" – **P24***

In these cases, the disruption leads to a reassessment of the affordances of the environment through the senses (scan), and some affordances may suggest (or not) a new course of action. The new course of action is evaluated, accompanied by experiences of making a micro-decision. The disruption, therefore, stops the "inattentional blindness" (Mack & Rock, 1998a), which makes the subject only pay attention to those affordances in the context that were relevant to their initial goal and makes them overlook other possibilities in the environment. So, the actor is put back into a more open-ended opportunistic mode and considers the multiple affordances of the environment, possibly leading to the MDM choosing one of the possible paths afresh.

In these activity sequences, following a disruption in the activity flow, participants scan the environment for affordances or possibilities for the next action(s). Upon gathering information, this process of identifying possibilities proceeds with the behavioural variable of Scan and is accompanied by MDM experiences. We then observed the continuation of the activity.

2. **Hesitation => Micro-decision => Identify Possibilities => Continue** (232 occurrences)

   *"I went for the smaller knife first, but it wasn't cutting well. Then I remembered that this is the smaller knife doesn't cut that good. The bigger one is more sharp. That's why you see me hesitating there, I decided to take the bigger one." – **P59***

In contrast with the previous, here, the reaction to the disruption is not exploring the environment but rather exploring one's own memory or knowledge. Similarly to the previous, what is found (retrieved) in the mind serves as a basis for the MDM. In this activity model, we observed the participant hesitating before identifying possibilities for action. This activity type was also accompanied by experiences of MDM.

3. **Shift => Continue** (200 occurrences)

> *"I was chopping vegetables, but then I realised I needed to start the rice cooker if I wanted everything to be ready at the same time. So, I rinsed the rice and got it started before going back to the vegetables." –* ***P40***
>
> *"I wanted to dust the tables, but I noticed the clutter and cleared them first."****- P18***

Contrary to the previous sequences, this one was not accompanied by MDM experiences in our data. In this model, a shift in activity indicates going from one task to another prior to completing the task at hand due to a distraction. After a minor shift in activity, the participant returned to the prior task at hand and continued the initial activity path. Interestingly, some of these shifts, as in the example above, consist of interrupting the current task to execute another task that should have started earlier to optimise the result and that has been forgotten. Something in the situation reminds the actor that this other task should be done.

4. **Hesitation => Micro-decision => Scan => Identify Possibilities => Continue** (191 occurrences)

> *[in the supermarket] "Yeah. So, then, I was also looking at the laundry [products], but they weren't the ones that I used to take before, so I was a bit confused at first, so you see me hesitating because I wasn't sure maybe I was in the wrong place? So I'm looking for them first, but then they [default laundry products] weren't there, so I was looking for the cheapest thing, but then there was no bio one. So, in the end, I didn't take any [laundry product] and went to the other aisles." –* ***P21***

This is basically the combination of sequences 1 and 2. As the internal reflection does not provide an adequate direction, the actor explores the environment (as in sequence 1).

5. **Scan => Identify Possibilities <=> Micro-decision => Activity Initiation** (180 occurrences)

> *"Like, I was hungry and not that hungry, and also having to finish that bowl of fruit before it expires as well. So, like, I sort of have a look if I have to finish the fruit, and I have to throw it away if I don't [eat them], so I just have a nectarine for breakfast." –* ***P47***
>
> *"I…I see that there is…clearly there's a pause, but it's not actually a pause, I'm scanning to see what to do." –* ***P34***

Here, there is no breach in the flow per se, but the actor is starting a new activity sequence because the previous goals have been ended. In a way, this provides the natural sequence of activity. There is a motive (e.g., hunger), and the actor assesses the environment to explore for affordances. Then, the affordances are assessed for relevance, and a path is chosen. The choice of the path, based on the evaluation of affordances, is the MDM. It is interesting to note that, while the participants are able to describe this process in great detail after the fact when they replay the Subcam tape in slow motion or frame by frame, the actual MDM was much faster and possibly not processed as a verbal chain of thought, as in the debrief, but rather as embodied "weighting" of the alternatives, as William Warren (1984) shows the capacity of subjects to evaluate with precision, by sight, if a stair is climbable for them depending on the height of the raiser.

The cases above (1 to 4) tend, after a disruption, to set the subject back to this initial stage of seizing the current situation, either at the level of a subgoal setting or possibly at the level of goal setting. How far they are set back and the strategies they use depend on the intensity of the disruption and its origin (self-disruption or external). Depending on how the installation's channelling is more or less strong and how the motive is more or less salient, the MDM may or may not occur and may or may not lead to a change of goal.

6. **Retry => Continue** (132 occurrences)

   This sequence represents situations where participants encounter a minor obstacle, attempt to overcome it by repeating their action, and then successfully continue their original activity (see section 5.2.1. Retry for details). We see this sequence operationally in our data as repeated physical action (e.g., twisting a jar lid multiple times), sometimes a brief pause between attempts, increased force or slight variation in technique on subsequent attempts (e.g., the participant changes their grip of the jar lid), and smooth transition to next step of activity after successful attempt.

> *"[I] scanned my fob and the green light indicates that the fob has scanned, but the door didn't open with my first push, so I just pushed again…yeah, retry, a bit harder, and it opened. It's a heavy door, this one."* ***– P23***

7. **Shift** (114 occurrences)

This sequence indicates instances where a disruption leads to a complete change in activity without returning to the original task. In the below example, the participant's activity is disrupted due to an external disruption, and she does not return to the previous activity. How we observe this activity sequence is through sudden interruption of current activity (e.g., stopping mid-motion), head turn or body orientation change (often in response to external stimulus), engagement in a completely different set of actions, sometimes changing the physical location, and no return to original activity within the observed time frame.

> *"I was unloading the dishwasher when I heard my phone ring in my headphones. It was an important call I'd been waiting for, I'm doing interviews to find a job, so I left the kitchen to take it in my room. After the call, I got caught up in some work and I actually completely forgot about the dishwasher. I think my roommate did the rest."* ***- P37***

8. **Pause => Micro-decision => Scan => Create Possibilities => Continue** (106 occurrences)

This sequence shows a more complex MDM process where participants pause, make a micro-decision, look around, generate new options, and then resume their original activity. We observe this sequence operationally with cues such as momentary cessation of all movement, and often we hear the participant making sounds that indicate annoyance or irritations (e.g., ughs and ohs), head movement as eyes scan the environment following the pause, and resumption of original activity, potentially with a new approach or in a different location.

> *"I'm absolutely frozen [laughs]; it was so funny because I was pulled the strings [of the rubbish bin plastic bag] so hard that it actually, like, was cut off, and I'm pausing and just like, staring at it, utterly heart-broken [laughs]. But seriously*

*though, I pause for like, how long was it? It felt like 20 seconds or so, but I'm actually deciding what to do, and then I kind of decide what needs to be done. Like, it's a bit hard to explain, but when I'm pausing, I'm trying to, like, visualise, and it's definitely that I need to use another [bin] liner, right? But then I'm scanning for the potential solution I thought of and to, like, materialise the solution and make it happen, if that makes any sense, and it worked. […] No, it's not something I'm used to, and this is actually the first time such a thing happened. I'm usually careful not to make the bin liners too heavy, so I had previously been concerned over the plastic bag leaking and stuff, but this was like, the first time I was faced with this issue, and I had to think of a solution on the spot, which is why I'm pausing there. I think it was a pretty good solution, actually. I started using two [bin] liners quite often from then." **- P42***

9. **Scan => Identify Possibilities => Continue** (82 occurrences)

In this sequence, participants briefly survey their environment, recognise available options, and then proceed with their original activity. We observe this sequence through brief head movements as eyes survey the immediate environment and the participant's attention shifts from one source to another, sometimes with a very brief pause on each option or affordance, and then quick resumption of activity with selected item or approach:

> *"I needed something sharper to fit in the sinkhole. I was scanning to see what I use, and the knife in the dishwasher looked like it would fit and do the job. […] Yeah, I did quickly kind of glance around the kitchen, spotted a few options in the drawer, chose the most suitable one, which was the sharpest [to remove the sinkhole blockage], and used it."* ***- P15***

10. **Micro-decision => Shift** (70 occurrences)

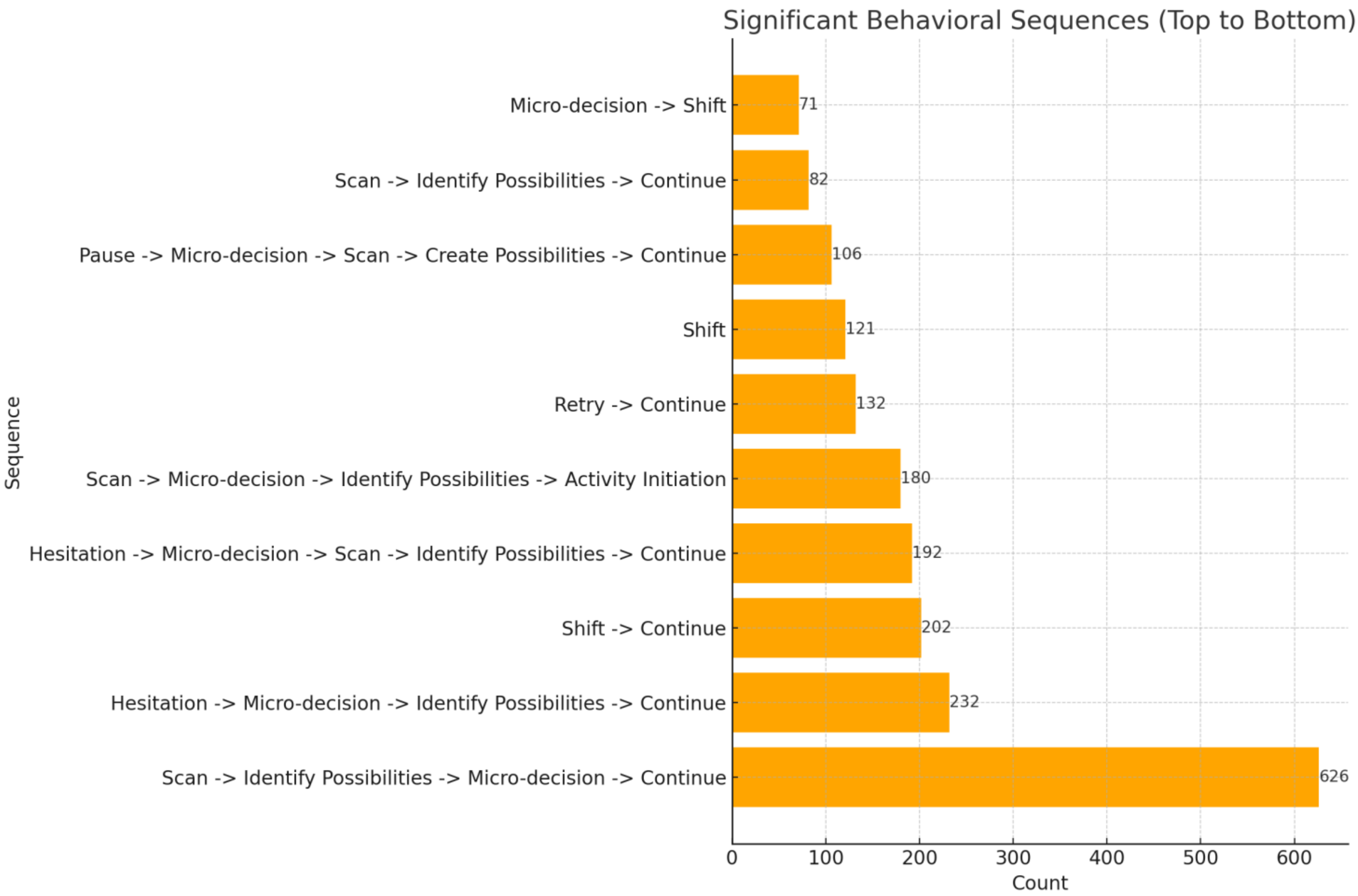
This sequence represents situations where a micro-decision leads to a complete change in activity. We often observe this shift following an internal disruption and without any external cues that would otherwise distract the participant and disrupt the activity. We also observe this sequence as an abrupt change in body orientation or location, engagement with entirely different objects or environments, and No return to original activity within the observed time frame. When asked about these seemingly reasonless shifts, participants often explain remembering something or noticing something that cues another task that they should or want to do:

*"I was about to eat, but then I remembered I had an urgent email to send to this woman that I call every day for charity purposes. I thought to send the email first before sitting down to eat, which is why I left it [food] on the table and went to my computer. […] Yes, it was a decision for sure." **- P29***

Figure 23 is a bar chart of the top 10 frequently observed activity sequences in the SEBE dataset sorted from least to most. This bar chart shows the total counts of various significant behavioural sequences. The sequences are ordered from the most frequent to the least frequent, providing a clear view of the number of times each sequence occurs.

Figure 24

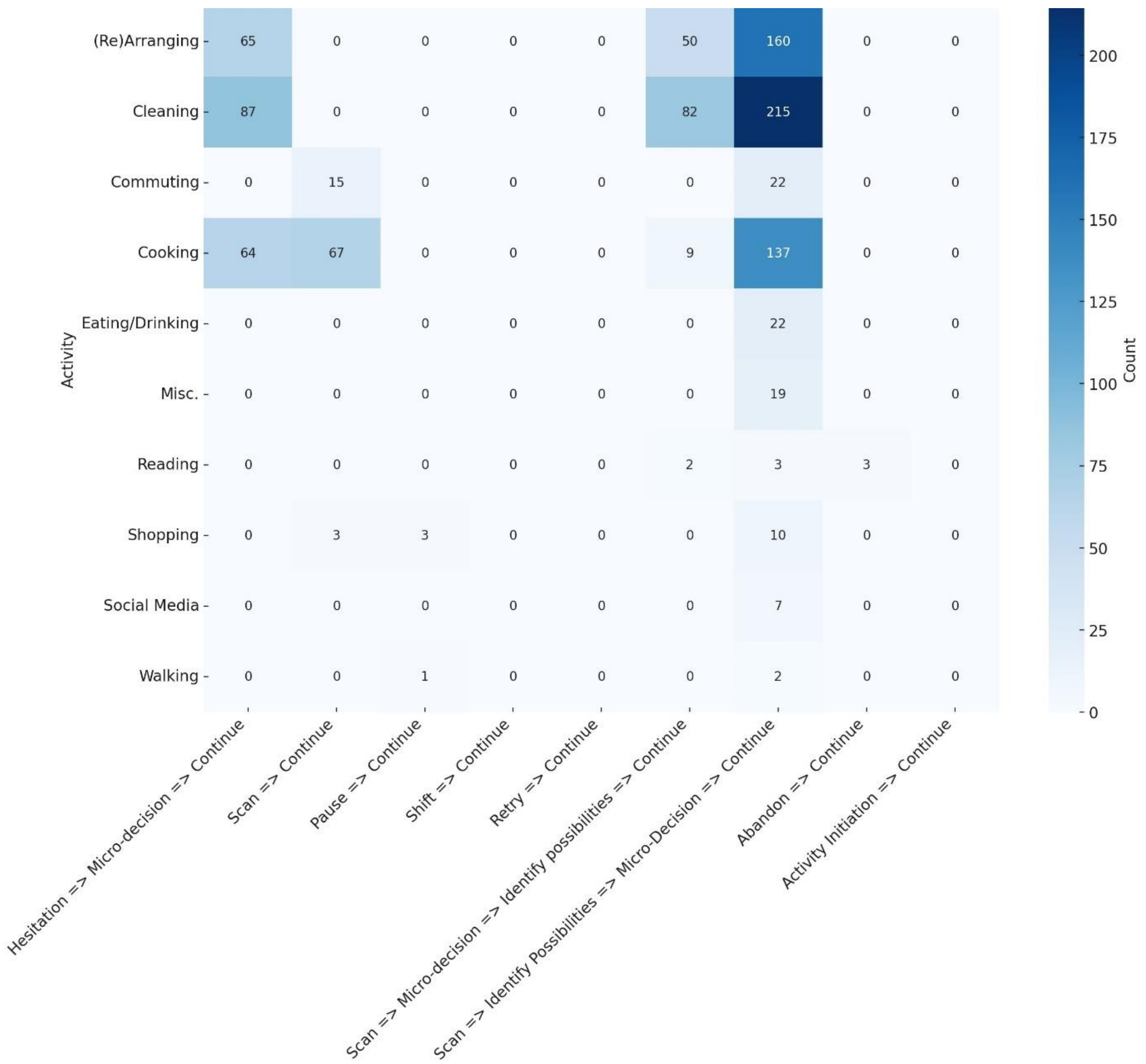
The top 10 frequently observed activity sequences in the SEBE dataset sorted from least to most



Moreover, we developed a heatmap to visualise the activity sequences across various everyday activities in our data. The heatmap below represents the most prevalent activity sequence across various specified activities. Each cell in the heatmap indicates the count of a specific sequence occurring within a particular activity. The heatmap provides a visual comparison of how frequently different sequences appear across various activities, allowing for an easy identification of patterns and differences.

Figure 25

Heatmap of the top 10 most prevalent activity sequences distributed across activities



Activities like Cleaning, Cooking, and (Re)Arranging involve more frequent micro-decisions compared to activities such as Commuting and Walking which are less frequently disrupted and more strongly guided by the installations. Many activities, including Reading, Social Media, and Shopping, involve pauses followed by micro-decisions, indicating stronger disruptions and, thus, deeper reorientation instances. This confirms that MDM processes vary depending on the type of activity, therefore one should remain cautious in generalising. In passing, this reminds us that results obtained on DM in laboratory conditions for specific tasks may differ from other types of conditions in natural settings.

Our next step in analysing the activity components was to further investigate the behavioural sequences and patterns of components, with a specific focus on transitions from one component to another and unravelling the peculiarities of retry and give-up behavioural variables. Our aim was to analyse any emerging key patterns across the various everyday activities we had in our dataset.

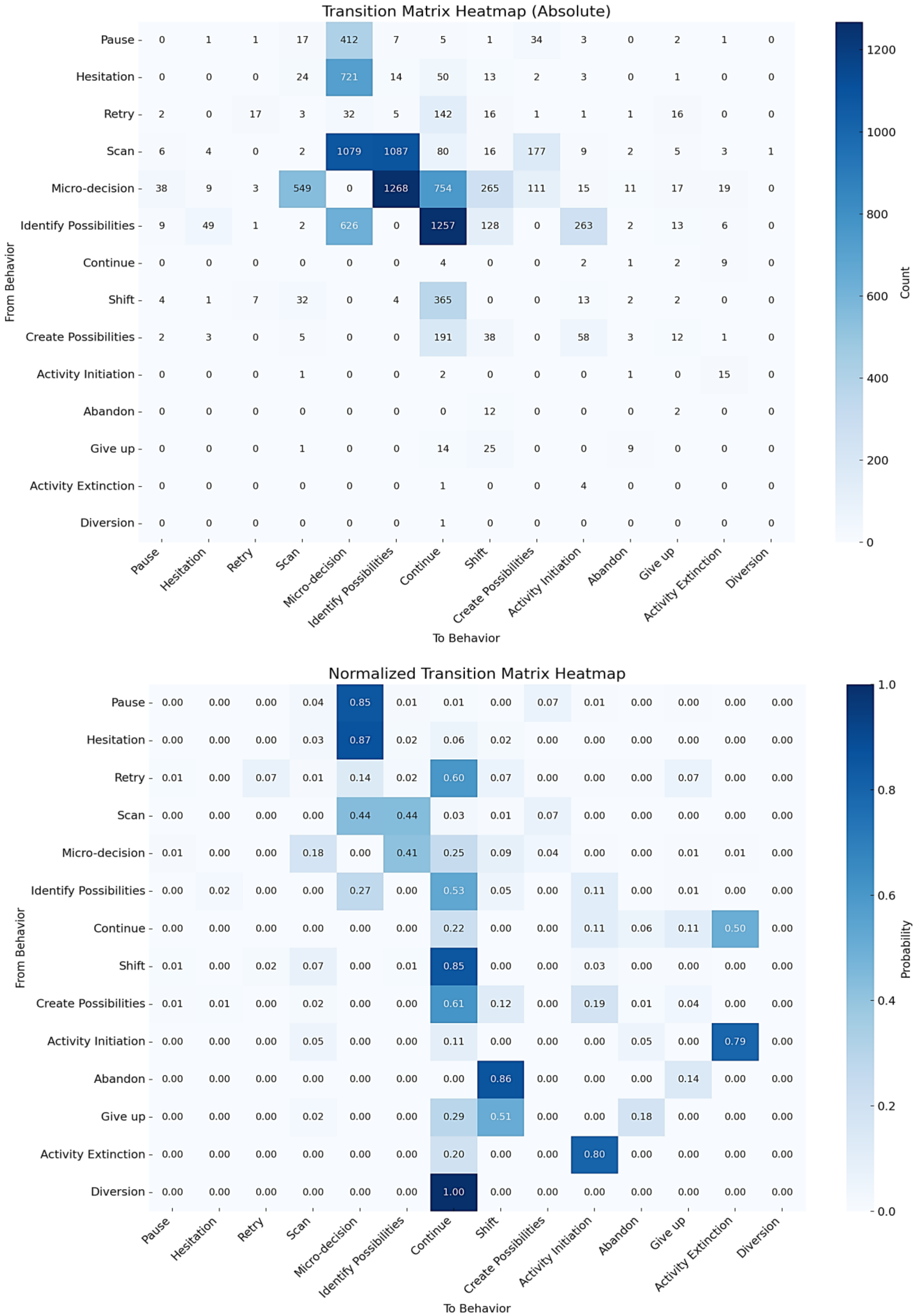
To begin the analysis, we examined the sequences of behavioural components and micro-decisions. Basically, we examined and coded the behavioural variables and components that preceded and followed instances of micro-decisions. Each row in our coding sheet represents a sequence where behaviours and micro-decisions are coded. For instance, a row with a value of 1 for "Pause" and "Micro-Decision" (coded as Decision in our coding sheet) signifies that a pause occurred followed by a decision, and then subsequent behaviours were recorded in the sequence. An example from our coding sheets and full descriptions of our variables and components can be viewed in section 4.2.5. Coding and Concepts of the Research design chapter. The dataset contained numerous sequences, but we focused on extracting the most frequent ones to understand common patterns. We identified transitions such as "Scan => Identify Possibilities <=> Micro-decision => Continue" and "Hesitation => Micro-decision => Identify Possibilities => Continue", which were among the most prevalent (see above). A sequence for each row was created by concatenating behaviours that had a value of 1. For example, if a row had Pause = 1 and Micro-decision = 1, the sequence would be Pause => Micro-decision. The transitions between behaviours were extracted by looking at consecutive pairs in the sequences. For instance, if a sequence was Pause => Micro-decision => Scan => Continue, the transitions would be:

- Pause to Micro-decision
- Micro-decision to Scan
- Scan to Continue

Using these transitions, we constructed a transition matrix, where the rows represented the "From" states and the columns represented the "To" states. The transition matrix helped us understand the flow of behaviours and micro-decisions. It provided insights into how likely certain behaviours follow others, which was crucial for analysing sequences. By normalising the transition matrix, we could quantitatively compare the likelihood of different transitions. To visualise our transition analysis, we developed two heatmaps in Figure 26 to demonstrate the results of our transition analysis. The heatmap visualisation of the normalised transition matrix (the figure below) provides a clear and intuitive way to see the most and least likely transitions. The colour intensity indicates the frequency of transitions, with darker shades representing higher frequencies. In the heatmap, the value in each cell represents the number of times a transition occurred from one state to another. The normalisation process converts the absolute counts of transitions between behaviours into probabilities by dividing each transition count by the total number of transitions originating from the same behaviour. This ensures that the sum of all transition probabilities from any given behaviour equals 1. For each row in the transition matrix, representing transitions from one specific behaviour, we calculate the total transitions (row sum) and then divide each individual transition count by this sum. This transformation results in a normalised transition matrix where each entry indicates the likelihood or probability of transitioning from one behaviour to another rather than the absolute frequency.

Figure 26

Heatmaps displaying the absolute (above) and normalised (below) counts of transitions between behaviours and activity components



One of the most likely transitions is from "Abandon" to "Shift," with a probability of 0.86 (86%). This high probability indicates that when participants abandon a task, they are very likely to shift to a different activity. This behaviour suggests that abandoning a task is very often followed by a reallocation of efforts to another activity.

Following this, the transition from "Diversion" to "Continue" has a probability of 1.00 (100%). This implies that when participants engage in a minor diversion, they always continue the same course of activity following the opportunity to complete a minor side-task or engage more of their resources.

The transition from "Hesitation" to "Micro-decision" has a probability of 0.87 (87%). This high probability suggests that hesitation often leads to experiences of making a micro-decision, indicating that moments of hesitation indicate reorientation where participants assess their situation and decide on the next course of action.

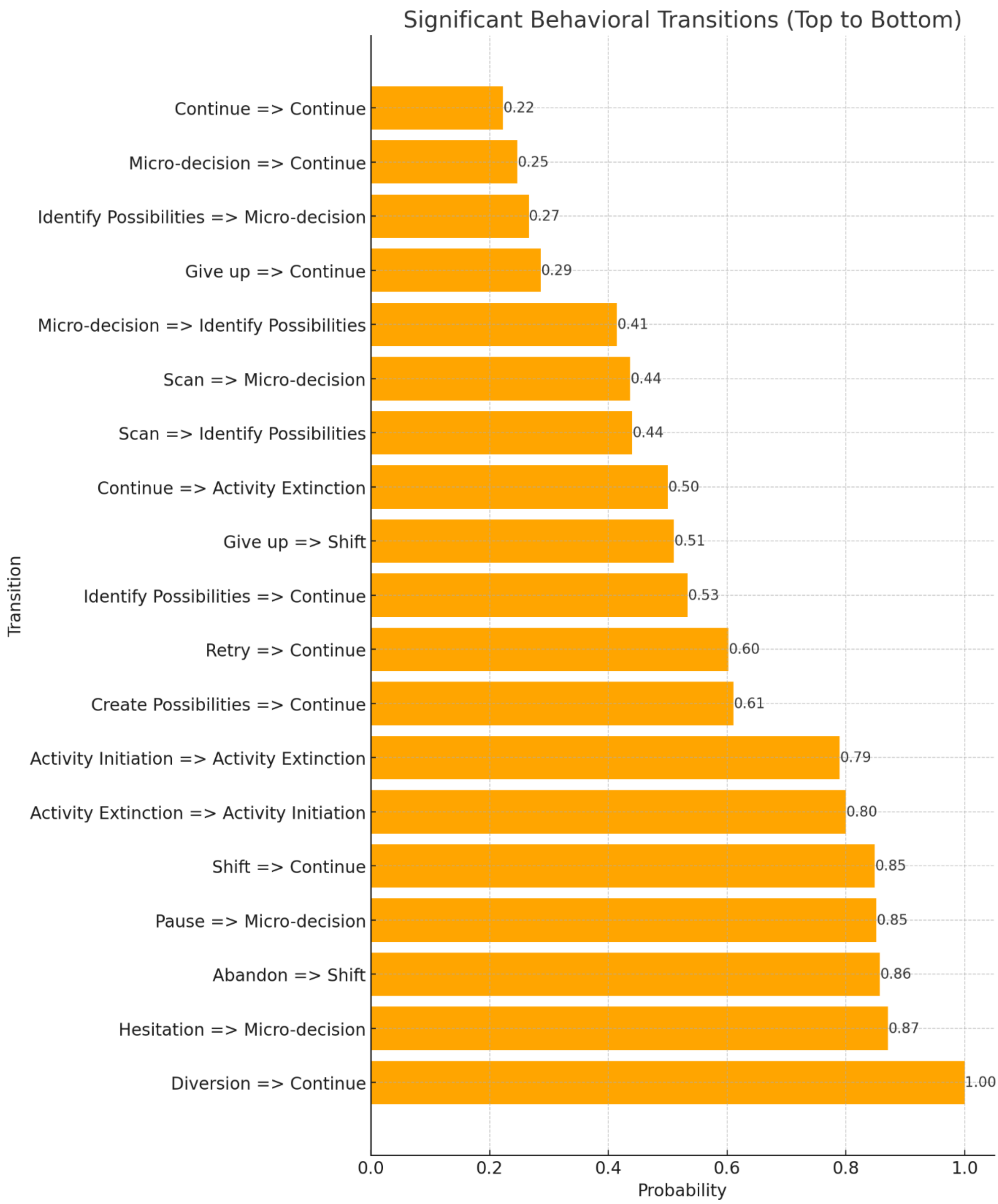
The transition from "Pause" to "Micro-decision" shows a probability of 0.85 (85%). This transition indicates that pauses are frequently used as opportunities for participants to reorient towards the goal, which is accompanied by MDM experiences. This highlights the reflexive role of pauses in activity and goal pursuit.

The transition from "Scan" to "Micro-Decision" has a probability of 0.44 (44%). This emphasises the importance of situational awareness, as participants often gather information by scanning their environment before making a decision. This underscores the necessity of evaluating the environment and its affordances for MDM.

Additionally, the bar chart below similarly highlights the most significant behavioural transitions from top to bottom. The normalised transition matrix was flattened into a list format to facilitate plotting. Each row in this list contains a “From” behaviour, a “To” behaviour, and the corresponding probability. A threshold was applied to filter out less significant transitions. For this analysis, transitions with probabilities greater than 0.2 were considered significant. The filtered significant transitions were sorted by their probability in descending order.

Figure 27

Significant behavioural transitions with probabilities greater than 0.2



Additionally, the transition from "Retry" to "Continue" has a probability of 0.60 (60%). This indicates that after attempting a retry, participants are likely to continue with the task and resolve the issue, showing persistence and determination to overcome initial failures.

Interestingly, the transition from Retry to Retry is 0.07 (7%), indicating participants' persistence to resolve the issue through retrying the same action. This is while the transition probability to Micro-Decision is just 0.14 (14%). The issue of retry proved to be a peculiar one in our findings as it was seldom accompanied by experiences of MDM and seemed to be more of an automatic response to minor obstacles before disrupting the activity flow. We delved deeper into this variable, hoping to understand and unravel it further. Upon analysing our dataset, we found that the success rate of retries (immediate or after successive retries) is approximately 70%. This indicates that when participants retry a task, they succeed about 70% of the time. Therefore, retry is a very successful heuristic. This conforms to Gigerenzer's theory that heuristics result from their empirical efficacy in naturalistic settings rather than from pure logic. Indeed, it apparently makes no logical sense to retry an action that just failed, but it works in practice. The average number of retry attempts is about approximately 3 attempts. This shows that participants often make multiple attempts before succeeding, or the activity flow becomes disrupted. We then focused on a transition analysis for retry across failed and successful retries. We found that when retrying fails to resolve any obstructions:

- **Give up**: When retries fail, participants transition to "Give up" 54% of the time. This indicates a strong likelihood of giving up (either due to activity abandonment or MDM avoidance) after an average of 3 unsuccessful retry attempts.
- **Micro-decision**: 35% of failed retries lead to a micro-decision, showing that participants often reassess their actions even after a failure.
- **Continue**: Only 11% of failed retries result in continuing with the task, indicating that failure typically leads to reassessment or abandonment. However, sometimes, people continue the action even if a task fails or a subgoal is not reached successfully. In a way, these instances are examples of an activity that is not successful. But that is what reality is; this happens.

For example, Participant 53, while attempting to organise their bookshelf, encountered a situation that exemplifies continuing despite failed retries:

> *"I was trying to fit all my books onto this one shelf, but it was really tight. I tried rearranging them a few times, each time thinking I'd get them to fit. After the third attempt, I realized they still wouldn't all fit properly without being squished or potentially damaging the books. But I was already halfway through the task and didn't want to rethink my whole organisation system. Yeah, so…the books weren't fitting as I wanted, obviously. I'm just continuing to put them on the shelf anyway,*

and you can see those, those ones, sticking out a bit. I knew it wasn't ideal, but I decided to just finish it and carry on."

Moreover, we found that when retry succeeds:

- **Continue:** When retries are successful, participants continue with their tasks 91% of the time. This high proportion highlights that success strongly encourages continuation.
- **Micro-decision:** Only 9% of successful retries result in a micro-decision, suggesting that participants are less likely to reassess their actions after succeeding and prefer to continue.
- **Give up:** No transitions to "Give up" were recorded for successful retries. This makes sense.

Our deeper analysis of retries provides valuable insights into how the outcome of this particular behavioural variable influences subsequent components and MDM. It highlights the importance of success in maintaining the activity flow and avoiding disruption. Disruption is preferably avoided, as it requires cognitive efforts since participants will need to reorient (unless they abandon).

This also demonstrates an interesting automatic mechanism (retry) that emerged from our data as a flow-maintaining and MDM-avoiding behaviour. It also suggests how cognitively expensive an activity disruption is for participants, thus putting some effort into avoiding it. The table below summarises our findings from a transition analysis of successful and failed retry attempts.

Table 7

The relationship between the success of a retry and the subsequent transitions

Success of Retry	Transition	Count	Total	Proportion
Failure	Continue	4	37	0.11
Failure	Give up	20	37	0.54
Failure	Micro-decision	13	37	0.35
Success	Continue	134	148	0.91
Success	Micro-decision	14	148	0.09

Moreover, we summarised the distribution of retries among the activities in which we the most notable retries followed by their success rates:

Table 8

Summary of the success rate of retries for different activities

Activity	Total Retry instances coded	Total attempts	Successful Retry count	Success rate (%)
Cleaning	117	207	90	77.6%
Cooking	53	88	35	66%
(Re)Arranging	23	38	15	65%

As the table shows, retry is a heuristic that is successful about 2/3 of the time in most activities, so it appears to be a good generic heuristic.

In terms of the other rather peculiar behaviour in our research, Give Up, we analysed the transition analysis to delve deeper into the behavioural components that follow instances which we coded as Give Up.

We hypothesised that giving up could be classified into two distinct types: **abandonment** due to a micro-decision and **avoidance** of MDM altogether. To test this hypothesis, we analysed sequences where "Give up" occurred and differentiated between those that coincided with a micro-decision and those that did not. Abandonment, marked by a micro-decision, reflects a conscious and deliberate choice to stop the task, likely after considering the options and deciding that continuation is not worthwhile. This can be interpreted as a strategic withdrawal when the effort outweighs the perceived benefits. Our transition analysis demonstrates that the likelihood of experiences of making a micro-decision to give up (abandon) is 0.21 or 21% in our dataset. This is obtained by observing whether, after the "Give up", the activity was abandoned.

On the other hand, avoidance, characterised by a lack of micro-decision, suggests an inability or unwillingness to engage in the MDM process, potentially due to overwhelming difficulty or lack of cognitive resources or motivation. This avoidance of MDM is followed by Shift or Continue, which means that, as for the case of 11% of failed retries, the actor simply continues the same tasks or another of the same activity without bothering further. Again, this is the mark of some kind of failure or incomplete control in the activity that is accepted as such. This is an important result. The avoidance of making decisions does not seem to have been described yet, likely because of a lack of observation techniques. In our corpus, this concerns 79% of the “give up” codes, which is a small number of occurrences (less than 50 out of some 2700), but that has important theoretical implications. For example, Participant 47 explained:

> *“That’s actually the next day…and it’s, I think after I got home from work. Yeah, yeah…I remember I was actually very tired cuz it’s Thursday and I had to go to bed early. There, I opened the fridge to see what to cook cuz I also had to think of something to take for the next day’s lunch, but I was totally paralysed by so many random ingredients there. The thing is, I basically had to think of something to make with what I had; I mean, it wasn’t something sitting there for me to choose and prepare easily. I actually had to make something up, and I was too drained for that. there were so many options, and I was tired after work. Instead of choosing ingredients and planning a meal…[laughs] I just closed the fridge! Apparently, I couldn’t decide, but I couldn’t. you know, I was just too drained and couldn’t decide for anything so I basically just ignored and skipped it entirely.”*

Moreover, we zoomed in on self vs. external disruption of the activity. External disruptions were often relatively easy to code as we could spot the disruption sources captured by the subcam and coming from the environment. However, self-disruptions were more difficult to capture by merely relying on the Subcam footage, so we had to unpack the instances through RIWs. Throughout our entire dataset (S2), we counted 1301 self-disruptions out of a total number of 2726 activity disruptions. This means that in our dataset, activity was self-disrupted by the participant in 47.74% of the entire disruption instances. Aiming to delve deeper into our transition analysis, we first identified rows in the dataset where self-disruption occurs. Next, we extracted transitions involving self-disruption and subsequent behaviours. Finally, we counted and calculated the likelihood of each transition involving self-disruption. The table below provides a comprehensive view of the key transitions involving self-disruption within the dataset, allowing for a clearer understanding of participant behaviour during self-disrupted activities. Each transition describes a change from one state (the "From" column) to another state (the "To" column) and provides details on how often these transitions occur and their likelihood. The total column is the total number of instances the starting state ("From") was observed.

Table 9

Most frequently observed key transitions involving self-disruption and their proportions

From	To	Count	Total	Proportion
Scan	Micro-decision	534	844	0.63
Hesitation	Micro-decision	413	470	0.88
Pause	Micro-decision	224	263	0.85
Micro-decision	Continue	396	728	0.54
Micro-decision	Identify Possibilities	215	728	0.30

The reason we conducted these analyses was to gain insight into self-disruptions. The relationship between self-disruption and activity sequences reveals that self-disruption often includes moments of reassessment and experiences of MDM. This typically happens after behaviours such as hesitation, pauses, and scanning. These behaviours are indicative of the participant taking a step back to reassess their current activity or situation and decide on the next steps. These moments often result in micro-decisions, which are critical junctures that determine whether the participant continues with the current action or explores new options. The high proportions of transitions from hesitation pauses and scanning to micro-decisions highlight the importance of these behaviours in the self-disruption process.

Before moving on to the next sections, it's crucial to emphasise that our analysis revealed a more nuanced understanding of the MDM process following activity disruptions. We found that the entire process following a disruption in activity flow can be characterised as reorientation, with micro-decisions embedded within it. What we found by closely analysing RIWs and RRIWs is that MDM is a mechanism participants engage into in order to reorient to continue the goal pursuit and motive satisfaction. Otherwise, they abandon or avoid MDM. By conducting a sequential analysis, we found that this reorientation is not a linear sequence but a fluid, iterative process where scanning, identifying possibilities, and MDM often overlap and repeat.

This understanding challenges the notion of micro-decisions as isolated events and instead positions them as integral components of a broader reorientation process. The reorientation process is dynamic and adaptive, responding to both internal cognitive states and external environmental cues. It involves a continuous interplay between perception, evaluation, and action, with micro-decisions occurring as pivot points that guide the direction of this process.

Having examined the prevalent activity sequences and their implications for MDM in everyday contexts, we now turn our attention to two particularly noteworthy behaviours observed in our data: retry and give up. These behaviours, while seemingly opposite in nature, both contribute to reveal, we believe, important mechanisms in how individuals navigate disruptions and challenges in their daily activities. The retry behaviour represents a persistent approach to overcoming obstacles, often serving as a low-cost, automatic response to minor disruptions. In contrast, the “give-up” code corresponds, as we suggested above, to two distinct processes, both involving the weighing of cognitive costs against potential benefits, but in a different manner. By dedicating specific sub-sections to these behaviours, we aim to provide a deeper understanding of their unique characteristics, triggers, and implications for MDM processes. This focused analysis will shed light on how individuals balance persistence and disengagement in their everyday DM, offering valuable insights into the adaptive strategies employed in navigating the complexities of daily life. We will first explore the retry behaviour, examining its frequency, contexts, and role in maintaining activity flow, before delving into the nuanced aspects of giving up, including its manifestation as decision avoidance rather than mere activity abandonment.

5.5 RETRY AND MDM

Our analyses revealed that retrying has a statistically significant negative coefficient (see Behavioural events and MDM), indicating that it is associated with a decreased likelihood of participants experiencing making a micro-decision. This finding suggests that Retry might represent a different type of process compared to the other behavioural variables positively associated with micro-decisions. In fact, as we will see below, retrying is precisely avoiding to make and MDM.

Upon closer examination of the instances of Retry in our data, we observed that participants often engaged in this behaviour as an immediate, almost automatic response to minor obstructions or challenges encountered during a task. For example, when Participant 27 encountered difficulty in opening a jar, their first reaction was to retry the action a few times before considering alternative strategies:

“I find the lid was too slippery, so I tried to open it, but I failed the first time, but then I tried it for a few times and there you go!”.

This pattern of behaviour suggests that retrying the exact same action might serve as a rapid, low-cost strategy for overcoming small obstacles without engaging in deliberative MDM. By repeating the action, participants aim to resolve the issue through sheer persistence or minor adjustments rather than by (consciously) evaluating alternative courses of action. This interpretation is supported by the observation that when retrying is successful, participants often continue with their original plan without reporting any explicit experience of MDM. Below is an example from Participant 36 as they were coding their data through the RRIW sessions:

Participant 36: *Retrying…there is a lot of retrying.*

Interviewer: *Do you feel like it [retrying] breaks the flow of your activity?*

Participant 36: *Maybe it's a little bit annoying, but I wouldn't say that I’m not in the flow anymore. Maybe if it wouldn’t work, then yeah…but no, I don’t think so, really.*

Overall, we counted 630 attempts, equating to almost 3 retry attempts every time such event occurred. So, our findings suggest that, on average, participants retried an action 3 times before perceiving it as an obstruction. When Retry fails to resolve the obstruction after 3 attempts (on average), participants are forced to reassess the situation and consider alternative strategies, which may then involve more thinking, processing, scanning, pausing and, thus, experiences of MDM. As Participant 47 described:

“I was looking everywhere to find some [the cleaning product], but nothing was there, so I decided to go and buy some. I was scanning initially, but then retried looking in the same places several times before I knew I had to do something about it.”

This example illustrates how the failure of Retry can lead to a shift in the participant's approach, prompting them to engage in MDM. The negative association between retrying the same action again and having to make a micro-decision in our analysis suggests that this behaviour represents a distinct mode of problem-solving, one that relies on automatic, habitual responses rather than deliberative MDM. By attempting to resolve minor challenges through repetition, participants may be seeking to minimise cognitive effort and maintain the flow of their activity, as it is cognitively expensive for the flow to break since it requires the participant to reorient towards the goal and reevaluate the situation. It is only when retrying fails to maintain the progression of activity and goal pursuit that they are compelled to engage in more effortful MDM processes. Participant 52 explained below the process they go through to fix the issue of their computer not loading the document they were working on. Only after some retries does the participant engage in MDM process; the retry per se is not considered as part of the MDM, just a continuation of the flow.

> ***Interviewer:*** *How come you're doing the same process again:*
>
> ***Participant 52:*** *Um…I'm not sure. I think that's just how I fix it; I retry. But then it didn't work.*
>
> ***Interviewer:*** *When did you notice that it's not working?*
>
> ***Participant 52:*** *I opened my doc [document], and it wasn't working. I tried reconnecting, but it didn't work, so I opened a browser to Google a solution.*
>
> ***Interviewer:*** *Did you experience this as making a decision to use Google for solutions?*
>
> ***Participant 52:*** *Yeah, yeah.*

In our data, retries predominantly occur in response to motor obstructions, particularly when participants encounter an obvious affordance that logically should work but doesn't on the first attempt. They are most common in situations where the action-perception coupling is clear and straightforward (see 6 Discussion), such as opening a jar lid, opening a door, scanning/swiping a card, pulling open a drawer, switching something on/off, etc. In these cases, participants have a strong expectation that the action should work because the affordance is obvious and logical. When faced with a failure to perform the action due to a motor obstruction (e.g., a lid that's too tight, a door that's jammed), participants immediately resort to retrying.

> *"I scanned [swiped] my card because the department door only opens like that, but then the door didn't open, so I pushed again." –* ***P23***
>
> ***Interviewer:*** *How come you pushed again?*
>
> ***Participant 23:*** *What do you mean?*
>
> ***Interviewer:*** *I mean, did you consider maybe that the department is closed, or your card is not working, or anything like this?*

> ***Participant 23:*** *No, because I push again, and the door opens. It was heavy, I had to push hard. But, maybe if I pushed hard more times and the door didn't open, I had to consider [other options].*
>
> ***Interviewer:*** *Did you decide to push again? I mean, was that something you experienced as having to decide over?*
>
> ***Participant 23:*** *Um…no, I think it was automatic, or because I use this door everyday, I know how it works, it's a door, it opens like that similar to all doors, push or pull.*

If there are several affordances, there is hesitation (e.g., when participants don't know where to put the dishes in the washing machine). So, when there are several affordances, participants seem to probe each affordance. This observation helps explain why retries are less common in situations with multiple or ambiguous affordances. For instance, Participant 1 described their experience with a stuck drawer:

> *"I tried to open the drawer, but it wouldn't budge. I knew it should open – I know how these things work. I just tried again and put a bit more force into it. It still didn't work, so I reckoned there is something behind it, blocking the drawer."*

This quote illustrates how the obviousness of the affordance (a drawer is for opening) led to an immediate retry when faced with a motor obstruction.

Our analysis indicates that while retries are indeed common for motor blocks, they are not universal. Factors such as the perceived effort required for the retry and the importance of the task can influence whether a participant retries or seeks an alternative solution.

Interestingly, retry behaviour often occurs without experiencing MDM. According to our participants, the body is doing action, and the mind is looking at what is going on. This suggests that retries are often automatic responses to motor obstructions occurring before conscious deliberation takes place.

When retries fail, however, participants often transition into a more cognitively demanding MDM mode, as Participant 1 explained above. This leads to a transition from automatic retry to conscious problem-sizing and problem-solving.

These findings highlight the importance of considering the role of automatic, non-deliberative behaviours in everyday problem-solving and MDM. While our study primarily focuses on MDM, the Retry behaviour reminds us that not all adaptive behaviours involve conscious, deliberative processes. By understanding the complex interplay between automatic and controlled processes, we can develop a more comprehensive model of how individuals navigate the challenges of everyday life.

In the next subsection, we will examine the Give Up variable, another peculiar instance that yielded interesting results in our analyses, and consider its implications for our understanding of MDM in everyday life.

5.6 GIVE UP (ACTIVITY ABANDONMENT VS. MDM AVOIDANCE)

The Give Up variable presents a puzzling case in our analysis of MDM in everyday life. While we initially expected Give Up to be a clear indicator of MDM, as it seems to involve a conscious micro-decision to abandon a task or goal, we were surprised by our logistic regression analysis results and our RRIW analyses and results, which revealed a statistically insignificant negative coefficient.

This suggests that there may not be a straightforward relationship between giving up on an activity and making a micro-decision. To better understand this finding, we conducted a detailed analysis of the verbatim explanations provided by participants during the RRIWs. Our further analyses revealed that Give Up could encompass two distinct scenarios: one, where it represents a clear decision to quit and abandon an activity or goal, and another, where it reflects an avoidance of the MDM process altogether. In fact, what the subject "gives up" in that second case is the process of MDM itself rather than the initial activity. Interestingly, here, MDM itself becomes an activity *per se* that can be avoided, likely because it is costly or complex and requires (excessive) cognitive processing. We thus divided this behavioural event into two distinct types: a micro-decision to abandon the activity and giving up on the process of MDM itself.

In some cases, participants described Give Up as a deliberate decision to abandon a task or goal after careful consideration of the costs and benefits. For example, Participant 22 explained their decision to give up on finding a snack that is healthy and suitable for their diet:

> *[in the supermarket] "I had been searching for [the specific snack bar] for a while, as you see me looking confused and going through the aisles, but I couldn't find it. It just wasn't worth it anymore, and I was a bit annoyed because of the mask, so I just decided to take something else."*

In this instance, Give Up involves a conscious re-evaluation of the situation and a decision to quit and abandon the initial goal based on that assessment. Another illustration of abandoning the activity following a micro-decision came from Participant 17:

> *"I think I just give up here."*
>
> ***Interviewer:*** *Do you remember why? Because you suddenly move on to something else.*
>
> ***Participant 17:*** *Well, I mean, I did consider preparing a meal, and I did start at one point, you see me there scanning the fridge, that's me starting to make something. But then I realised it'll take at least half an hour, probably more, so I just gave up and took some leftovers, we had some food left from yesterday.*
>
> ***Interviewer:*** *Okay, interesting, and did you experience this as making a decision?*
>
> ***Participant 17:*** *Yeah, definitely!*

However, in other cases, participants' descriptions of Give Up suggested that they were not so much deciding to quit as they were avoiding the need to make a decision altogether. Participant 41 provided an example of this when describing their attempt to fix a faulty drawer:

> *"That one is a pain! I had been struggling with this damn thing [drawer] for a long time, and I just couldn't figure it out. I got frustrated and just left it as it was. Yeah, I think it's a give up there."*
>
> *When asked if they experienced this as a decision, the participant responded,*
>
> *"Um…Not really. I don't think so. It was just leaving for another time, maybe. I just couldn't be bothered. It wasn't really a decision; I was just trying to avoid having to deal with it."*

Another illustration is when Participant 19 attempted to hoover a hard-to-access area while she was hoovering the room. The thumbnails from these examples can be viewed in section 4.2.5. Coding and Concepts, as part of our explanation of our coding and concepts. Following 2 seconds and 3 overall attempts to hoover the area, she gives up and moves on to other areas:

> *"I try to get the machine [hoover] to that little space, but I realise it's really hard to [access the area], so I give up!".*
>
> ***Interviewer:*** *How come you give up? Do you remember what went on in your mind?*

Participant 19: *It's very late [in the evening], and I'm very tired. I want to go to bed soon.*

Interviewer: *Did you decide to stop? I mean, did you consider moving the bedside table to try and reach it?*

Participant 19: *No, I didn't consider. I don't think it was a decision. I was tired and wanted it [hoovering the room] to finish to go to sleep.*

This distinction between abandonment (deciding to give up) and avoidance (giving up as a means to avoid MDM) is crucial for understanding the complex nature of MDM in everyday life. It suggests that the behavioural coding of "Give Up" in our study may have included both instances where participants made a clear micro-decision to quit and instances where they were simply avoiding the cognitive effort of MDM. The verbatim analysis also sheds light on what participants do after they abandon or avoid. In some cases, they may change their goals or priorities, as in the example of Participant 22 (in the supermarket) and Participant 17 (searching the fridge), who resided for something else instead of what they were initially expecting to find. In these instances, Give Up is followed by a clear micro-decision to change goals or priorities and abandon the current activity, demonstrating a form of adaptive MDM in response to challenges or setbacks.

In other cases, they may simply postpone dealing with the task or decision, as in the example of Participant 19, who avoided having to solve the issue since they were tired, and Participant 41, leaving the drawer because they couldn't be bothered with it there and then and did not want to have to engage in assessment, evaluation and orientation processes which were required for the MDM process embedded within the situation. These different outcomes further highlight the heterogeneity of the Give Up variable and its complex relationship to MDM and that this variable needs to be interpreted, coded, and analysed differently in the presence or absence of MDM. It can encompass a micro-decision to abandon, or it can be an avoidance of having to engage in MDM.

Moreover, these examples highlight the importance of considering the temporal dimension of MDM in everyday life. While some instances of Give Up may be followed by immediate decisions or changes in goals, others may involve a more extended process of deferral and revisiting the MDM process at a later time. This suggests that the relationship between Give Up and MDM may not always be captured within the narrow temporal window of our behavioural coding but may instead unfold over longer timescales, as suggested by Madsen (2017)

To further analyse Give Up behaviour in our data, we counted how many of these were avoidance of MDM and how many were deciding to abandon the activity. Out of the total 60 occurrences of Give Up that were coded and confirmed in our subfilms, 34 (56.7%) were avoidance, and 26 (43.4%) were abandonment. We then examined the behaviours following instances of Give Up across various everyday tasks. The bar chart below visualises these behaviours that followed instances coded as Give Up. The absolute bar char is then followed by a normalised bar chart for which we normalised the absolute counts to reflect the proportion of each behaviour relative to the total number of Give Up instances. This normalisation allowed us to compare the behaviours more effectively. Finally, Figure 30 shows the result of our correlation analysis, for which we calculated the correlation between each Give Up behaviour sequence and experiences of MDM ($df = 58$). When Give Up is followed by Abandon ($r = 0.11$), Hesitation ($r = 0.20$), and Scan ($r = 0.06$), behaviours, the sequences are positively correlated with experiences of MDM. These positive correlations, albeit weak, suggest that these behaviours are more likely to be accompanied by experiences of MDM. This aligns with our qualitative observations, where participants reported conscious deliberation during these behaviours. Conversely, when Give Up is followed by Continue ($r = -0.08$) or Shift ($r = -0.11$) behaviours, the behaviour sequences are associated with avoiding explicit MDM. It's important to note that the weak correlations observed between Give Up behaviours and MDM (-0.11 to 0.20) might be partially attributed to the relatively small number of total Give Up occurrences in our dataset, with only 60 total instances.

Figure 28

Absolute transition counts from Give Up occurrences to other behaviours

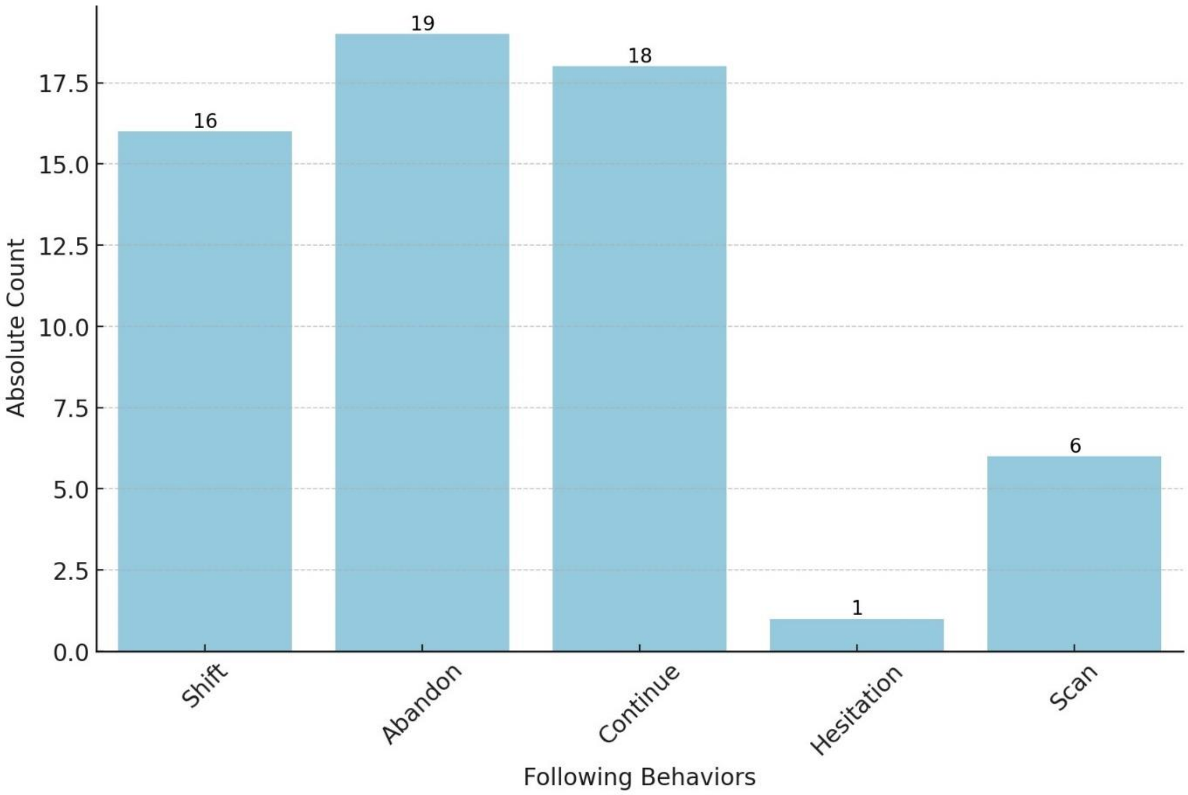


Figure 29

Correlations Between 'Give Up' Behaviours and MDM

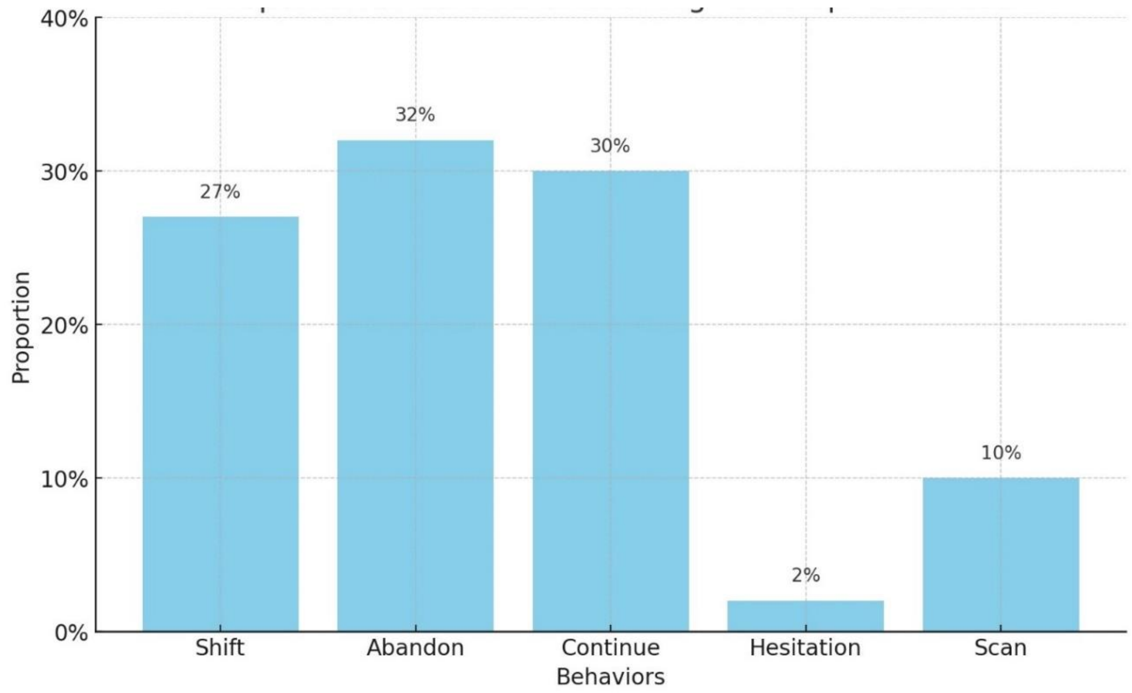
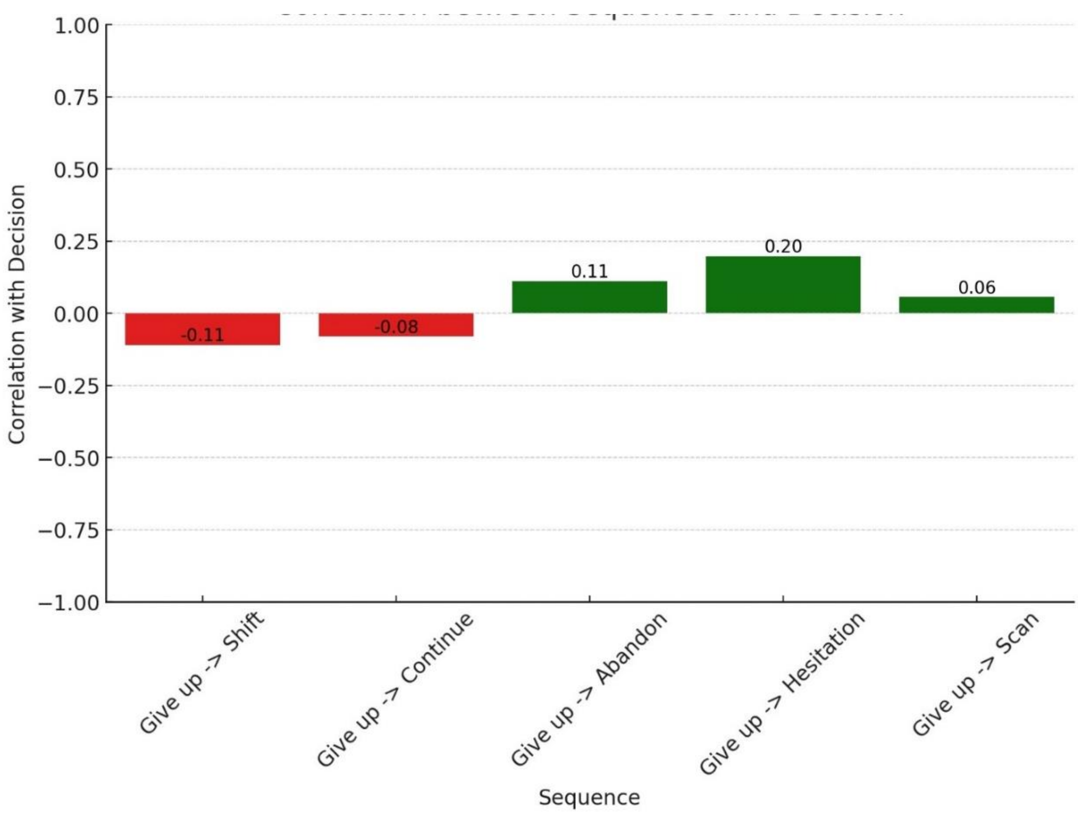


Figure 30

Proportion of following behaviours from the total occurrences of Give Up



Below we present some examples from the participants' explanations of different sequences of avoidance and abandonment:

1. Give up (Avoidance) => Shift

> *"I was, I think, too tired to have to deal with that [booking a train ticket], or I might just be procrastinating maybe, I'm not sure, but I just randomly go on Facebook and scroll a bit." – **P15***
>
> ***Interviewer:*** *Did you experience this as making a decision to sort of, shift from booking your train ticket to Facebook?*
>
> *"Um, it's tough to say but I don't actually recall like, [gestures quote unquote] deciding over this. I think I just didn't have the mental capacity to have to do all the plannings that needed to be done before booking the tickets, you know?" – **P15***

2. Give up (Avoidance) => Continue

> *"No, it's not that I abandoned cleaning, you can see that I'm still cleaning; I didn't decide to quit cleaning, but it's just that the dishes can be organised later, it's not really necessary and it's already, how much, like 30, 40 minutes that I'm cleaning and I'm clearly tired, so I just leave that for later and um…I skip that certain task [putting the dishes back]." – **P40***

3. Give up (Abandonment) => Abandon

> *"I tried to clean the thing [vacuum] but look, there is just so much hair stuck in the brushes, it's impossible to do hand I though, and actually I tried a couple of times, but I just gave up on it eventually." – **P29***

4. Give up (Abandonment) => Hesitation

> *"I'm hesitating here, the WiFi wasn't working and, I mean, when this happens, I always restart and it starts working again, but I restart there and the tabs are still stuck and it's just frozen and won't do anything. I tried refreshing a few times, the hesitation is like, I'm thinking whether I should force another restart or like, quit Safari and reopen, but I just give up on it eventually, I'm out of ideas, I think I come back to it later." – **P51***

5. Give up (Abandonment) => Scan

> *"I started looking through the [puzzle] pieces again, it felt like a loop, definitely not making any progress there. I think I eventually just stop…yeah."* ***– P60***

Our analysis of Give Up behaviours in everyday tasks reveals a complex interplay between MDM, task abandonment and MDM avoidance. While we need further analyses and data to draw conclusions, we found patterns in our data that support our hypothesis of a distinction between deciding to abandon a task and avoiding MDM. The positive associations of Abandon, Hesitation, and Scan with MDM, contrasted with the negative associations of Continue and Shift, suggest the difference between the two types we identified. Future research should delve deeper into the contextual factors influencing these behaviours and explore potential interventions to optimise task engagement and completion in everyday life.

5.7 SYNTHESIS OF THE CORE FINDINGS WITH A HYPOTHESIS AND A MODEL

Our research suggests a fundamental mechanism that would contribute to govern MDM in everyday life, which we propose as a refinement of more classic Activity Theory (Engeström et al., 1999a; Kaptelinin et al., 1995; Leontiev, 1978; Nosulenko et al., 2005). This mechanism involves a continuous process of comparing expectations (e.g., derived from previous experiences) to the actual unfolding of events. When the actual incurring experience aligns with expectations, the activity flows smoothly. However, when there is a significant discrepancy between expectations and reality, a disruption occurs, leading to a break in the flow of activity. The disruption can come from a material problem with affordances in the external context (e.g. motor block with a heavy door or a tight lid), but also from realizing that there is a problem with what the sequence should be (e.g. realising the rice cooker has not been turned on in time).

The findings suggest a continuous checking mechanism by which individuals assess their environment's affordances to fulfil their goals. This mechanism aligns with a basic MDM process, where the result of sensory exploration (i.e., affordances or what can be done) is compared to the potential motor actions that could lead to the (sub)goal. This process is fundamental in maintaining the flow of activity, provided that the sensory affordances meet the expected outcomes.

Let us illustrate again with the example of P19 trying to stop the washing machine or P12 looking for salsa: in the course of action, they search the environment for the desired affordance:

> *"I want to stop the wash [cycle] to add one cloth I forgot and I'm looking for stop button [...]". – **P19***
>
> *"I was looking at the Mexican section because I was looking for salsa. I had nachos at home, and I wanted to make baked nachos, so I was looking for salsa for that [...]". – **P12***

When disruptions occur, the nature of the disruption dictates the subsequent response. If the disruption arises from the failure of a motor action, subjects often retry the same action without engaging in MDM. See P19:

> *"I want to stop the wash [cycle] to add one cloth I forgot and I'm looking for stop button. There is scanning; it looks like pause, but I'm scanning because I'm looking at the [control panel on] top, at all the buttons. And then I find it, and I retry, I think, three times to stop the washing [cycle]."*

If the retry fails or the subject perceives no benefit in retrying, they scan for alternative affordances. This scanning may lead to the discovery of multiple affordances, necessitating MDM to choose the most suitable path. Interestingly, this process can sometimes lead to a change in goals due to the expanded perception and new opportunities that arise from overcoming inattentional blindness, as P12 finally decides not to buy salsa:

> *"I was looking at the Mexican section because I was looking for salsa. I had nachos at home and I wanted to make baked nachos, so I was looking for salsa for that, but I didn't end up finding a salsa which I liked, so I didn't buy it."*

If the disruption is internal (self-disruptions), stemming from the assessment that the motor task is not yielding the desired outcome (despite no external obstruction), the initial response tends to be internal exploration, consulting memory and internal representations. This internal focus is a reflection of the internal disruption and often precedes external exploration to verify or seek out hypothesised affordances. Participant 54 explained their experience of cooking from a Hello Fresh recipe that they had cooked before and attempted to recook the recipe, initially without referring to the instructions:

> *"I was making the pasta sauce from a Hello Fresh recipe I had before really liked! But like, I couldn't remember if I needed to add the herbs before or after simmering. Yeah, I paused for a moment; it's a pause; I'm trying to remember the last time I cooked it. I was pretty sure I'm meant to add them before, but I wasn't 100% sure. So, after a brief struggle, I decided to look it up again [from the recipe]."*

In response to such disruptions, individuals employ two main strategies. The first is to attempt to resolve the issue through a simple "retry" without engaging in deliberate MDM. This retry mechanism serves as a rapid, low-cost approach to overcoming minor obstacles and maintaining the flow of activity. However, when the retry fails or when the disruption is too significant to resolve through a simple repetition, individuals are compelled to enter a more cognitively demanding MDM mode.

Let us consider P19 and her washing machine example again:

Before the participant engaged in retrying (in page 91, Figure 14), they explained:

> *"I want to stop the wash [cycle] to add one cloth I forgot and I'm looking for stop button. There is scanning; it looks like pause, but I'm scanning because I'm looking at the [control panel on] top, at all the buttons. And then I find it and I retry, I think, three times to stop the washing [cycle]."*

When retrying fails to stop the cycle (after attempting three times) and unlock the washing machine door, the participant then asks their roommate for a solution:

> ***Roommate:*** *[00:09:27] No, you cannot open it.*
>
> ***Participant 19:*** *I did open it last time. I forgot to put one of my clothes into the washing machine.*
>
> ***Participant 19:*** *[00:09:45] I think this time it would work.*
>
> ***Participant 19:*** *[00:10:20] Do you think it's starting to wash?*
>
> ***Roommate:*** *[00:10:25] I don't know; I suggest you restart [the washing machine].*

The participant then moves to the control panel and scans again to find the on/off button for the washing machine:

> *"I'm trying to find the button for [washing] machine."*

In this MDM mode, individuals engage in an extended perception-action loop, which involves exploring the environment and/or their memory to identify new possibilities for action (Neisser, 1976; Norman, 1988). This exploration process is evidenced by observable behavioural variables such as pauses, scans, and hesitations, which correspond to the processes of assessing the situation, seeking information, and weighing options. At any stage of this MDM process, individuals may choose to abandon the pursuit of the goal altogether, a behavioural variable we have termed "abandoning" and the subjects describe as "giving up".

Interestingly, our analysis revealed that "giving up" does not always constitute a decision to abandon the activity. Instead, it often rather represents an abandonment of the MDM process itself, suggesting that individuals sometimes choose to avoid the cognitive cost of DM by disengaging from the activity or goal (which we call "DM avoidance"). The RIW suggest this avoidance is due to the evaluation that the effort of MDM is not worth its cost, or at least not in the moment, or that due to fatigue, the participant is not willing to engage now in the effort of DM. This is much akin to a transaction cost with the environment that would be necessary to incur to perform the MDM. For example, Participant 33 described a situation while putting away the newly bought grocery items upon their arrival at home:

> *"I just got back from [grocery] shopping in this one [clip]."*
>
> ***Interviewer:*** *Was this just a normal, routine grocery shopping, or something in particular that you had to shop for?*
>
> ***Participant 33:*** *No, it was just a very typical weekly grocery shopping. […] Our refrigerator is very small, and I have to rearrange the things in the fridge to open up some space for the items. I put away things like fruits and vegetables that have to go in the fridge soon, and ice cream as well. It will melt. But then I remember I had to cycle back home, and I was tired, so I decided to leave the other stuff on the counter there and grab a snack…yeah, I take the apple and rest for a while.*
>
> ***Interviewer:*** *Did you experience this as making a decision to abandon what you were doing?*
>
> ***Participant 33:*** *Um…yeah, because I did consider organising everything, and actually that was my plan first [initially], but then I was more tired than I thought I would be, so I decided to not do this [then], but also because, I mean, the bread and those items won't go perished or anything. I put the fresh items in the fridge, but you can see there that the fridge is really full and I need to do some serious*

> *organising to be able to fit the other stuff, so it was just more work than I thought, and I was tired so I just decided to do it later and postpone.*
>
> ***Interviewer:*** *Did you eventually come back to complete this because we don't have it recorded?*
>
> ***Participant 33:*** *I think so, yeah. Eventually I did later in the evening, and that was also a decision.*

This finding highlights the complex nature of MDM, its cost, and the importance of considering individuals' subjective experiences as they navigate disruptions and challenges.

When not abandoned, the outcome of the MDM process leads to a reorientation of the activity. This reorientation can manifest as a continuation of the original activity with a modified approach or as a shift to a new activity that still serves the overarching goal. The MDM process continues until the goal is achieved or until the motivation for pursuing the goal is exhausted, leading to the extinction of the activity.

The findings refine Activity Theory by detailing the coupling mechanisms between motor actions and affordances. The study highlights the parallel processing involved in representing actions and reflections, particularly when straightforward exploitation of affordances fails. In these instances, behavioural variables such as pause, scan, and hesitation indicate a reorientation process taking place, often including MDM. The results also emphasise that retrying an action does not constitute MDM, as it is a straightforward attempt to achieve the goal without reorientation.

A significant insight from the study is the parallel between the observed human DM processes and the error detection mechanisms used in training AI models. In both contexts, disruptions (or prediction errors) trigger a reassessment and learning process. The study distinguishes between simple motor failures (which can stem from either affordances or competencies), and internal disruptions. Internal disruptions suggest the detection of prediction errors due to a mismatch between expectations and experiences.

The proposed models (Figures 31 and 32) capture the fundamental mechanism of comparing expectations to actual outcomes, and the subsequent orientation and MDM processes that occur in response to disruptions. Figure 32 presents a flowchart that illustrates the two main strategies within the activity process identified in our synthesis: retrying the action as a low-cost approach and entering a more cognitively demanding MDM mode when the retry fails.

Figure 32 also represents the activity process in our data, beginning with the initiation of an activity and moving through various stages based on the evaluation of actions and outcomes. Below is step-by-step explanation of each part:

1. **Start Activity**: The process begins with the initiation of a specific activity.
2. **Perform (Next) Action**: This step involves performing a designated action related to the activity, trying to reach the goal in the conditions given, possibly channelled by installation.
3. **Prediction Error?**: During action, the process checks for any prediction error:
   - **No Error**: If there is no error, the process continues to perform the next action.
   - **Yes**: If there is a prediction error (e.g., action is blocked or does not produce the expected result), the next step is to retry the action or reorientation

4a) **Retry Action?**:

- **Yes**: the action is performed again.
- **No**: the process moves to reorientation.

4b) Avoidance?

- Yes: If the MDM process is avoided, the sequence loops back to continue the activity by accepting the prediction error (resulting in a degraded result).
- No: the process moves to reorientation.

4c). Abandon Activity?: The decision to abandon the activity is considered:

- **Yes**: If the activity is abandoned, the process ends with abandonment.
- **No**: the process moves to reorientation.

5) Reorientation: The situation is reassessed: an exploration and possibly MDM takes place. The reorientation can involve pause, hesitation, scan etc. the reorientation produces a new step for action (step 2), and expectations.

5. **Continue (back to step 2): Perform Next Action.** If there is no prediction error, the process checks if the goal has been attained.
6. **Check if Goal is Attained**:
   - **Yes**: If the goal is attained, the process concludes with extinction, indicating the end of the activity.

- **No**: If the goal is not attained, continue and perform the next action as expected from the current situation and goal.

Figure 31 provides a more detailed representation of the perception-action loop and the role of prediction error detection in activity aligning with the extended perception-action loop described in the synthesis, where individuals explore the environment and/or their memory to identify new possibilities for action when faced with a significant disruption.

It's important to note that while our model presents abandonment and avoidance as distinct paths outside of the reorientation process, this is a simplification for clarity. In reality, as our data shows, these decisions can sometimes be part of the MDM process within reorientation. The placement of these elements outside the reorientation box in our model is primarily for visual clarity and simplification.

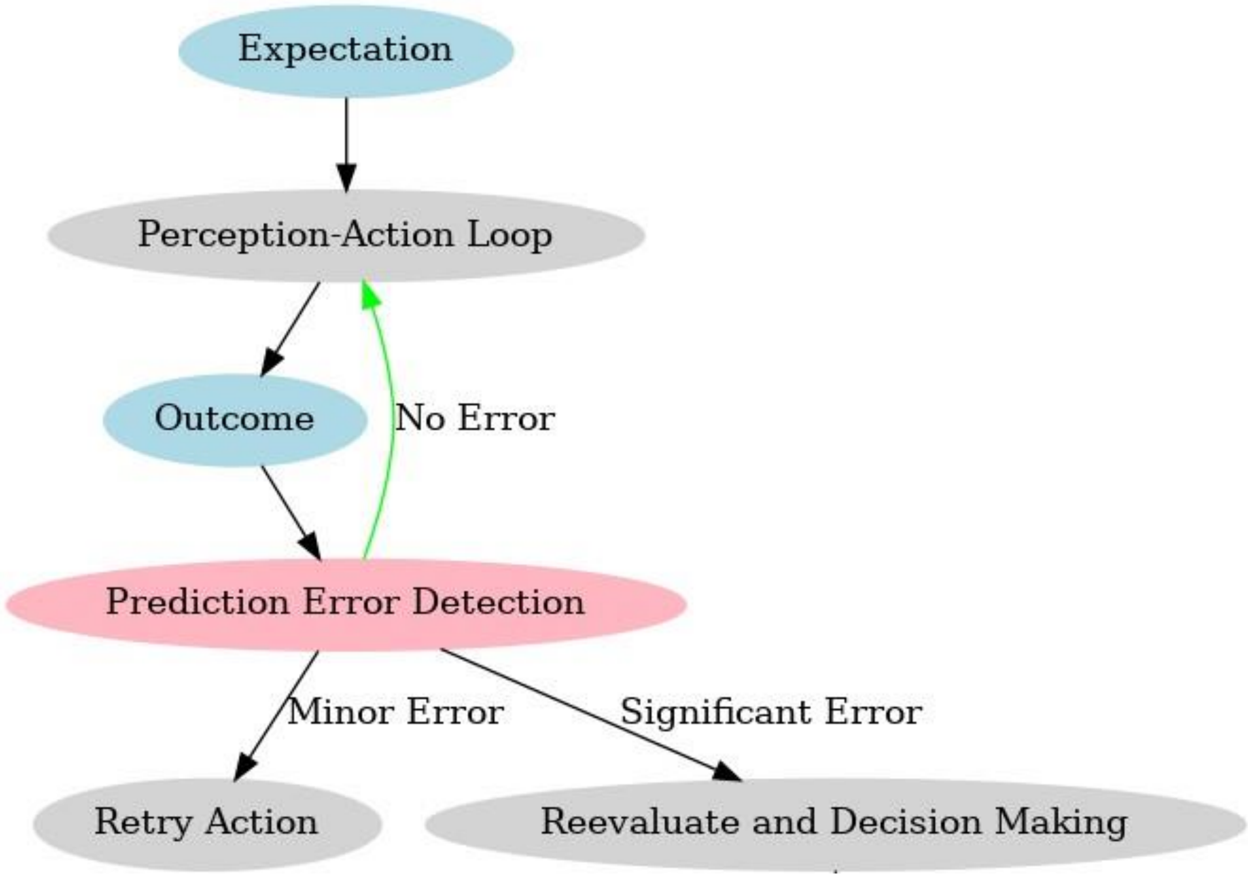
This simplification highlights one of the key limitations of representing complex cognitive processes with box-and-arrow models. The actual processes of DM, reorientation, and activity flow are more intricate and temporally intertwined than can be fully captured in such a model. For instance, the decision to abandon an activity might sometimes occur after a series of reorientation attempts, or it might be an immediate response to a significant disruption.

Moreover, the model doesn't fully capture the fluid nature of these processes. In real-world situations, individuals might cycle rapidly between different stages or experience multiple stages simultaneously. The boundaries between “Retry”, “Reorient”, and “Abandon” can be blurred, with decisions often made in a more continuous and less discrete manner than the model suggests.

Despite these limitations, we believe this model provides a useful framework for understanding the general flow of activity and MDM processes in everyday contexts. It serves as a starting point for more nuanced investigations into the complexities of human behaviour and cognition in real-world settings.

Figure 31

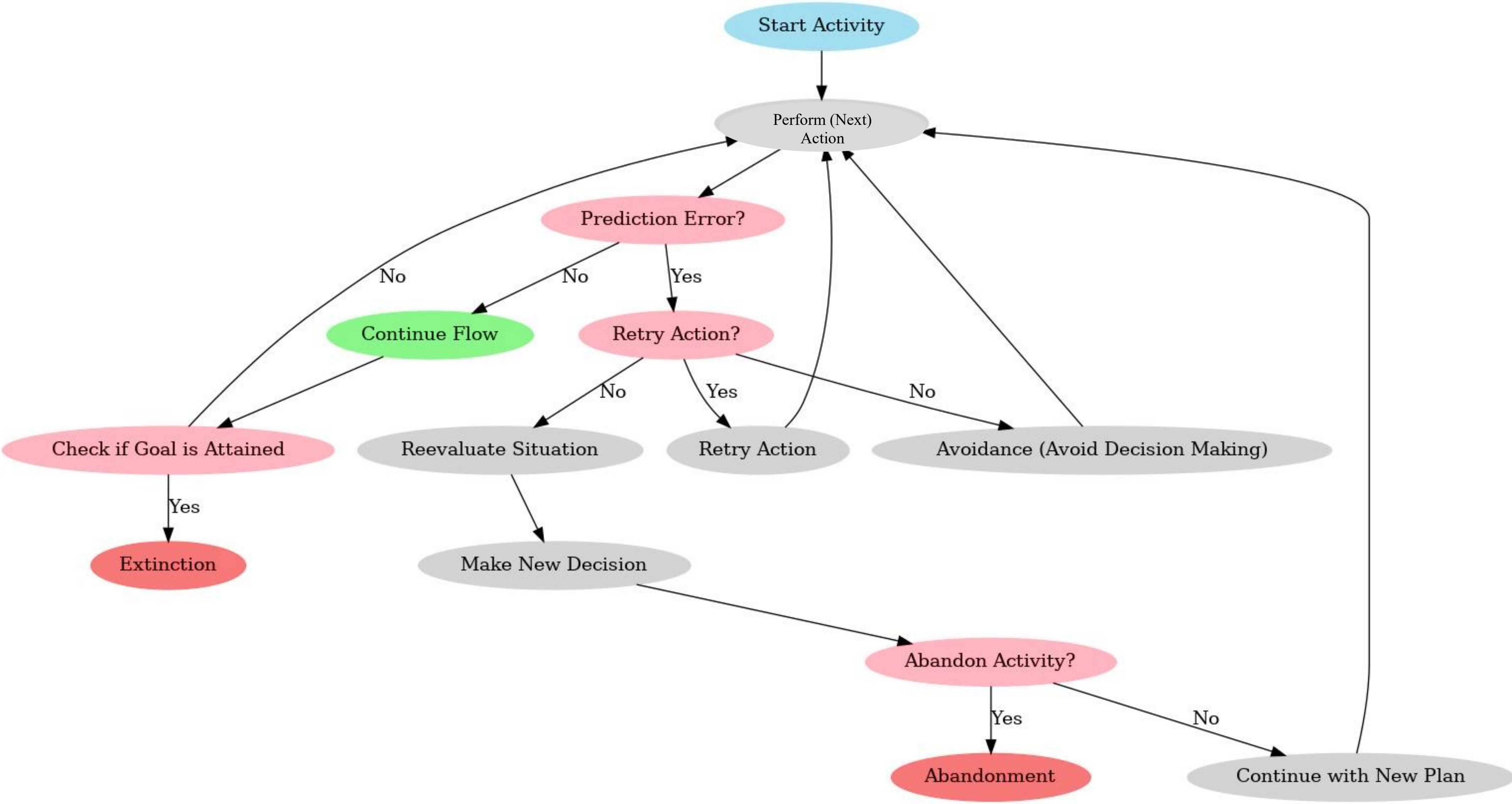
Model of the perception-action loop in everyday activities



Note. The model illustrates the role of prediction error detection in MDM, emphasising the distinction between minor errors that lead to retrying actions and significant errors that necessitate re-evaluation and reorientation

Figure 32

Flowchart of the activity process involving various actions and evaluations to determine the subsequent steps



The flowchart represents our identified activity process, which begins with an initial expectation and involves various stages based on the evaluation of actions and outcomes. The main distinction between the two figures lies in Figure 31's emphasis on the continuous and fluid flow of action through a feedback loop for no prediction error scenarios, making it more reflective of dynamic and adaptive real-world processes. The model simplifies error handling and incorporates a continuous perception-action loop, improving efficiency and responsiveness compared to Figure 30. Below is a step-by-step explanation of each part of Figure 30:

1. **Expectation**: The process starts with an initial expectation, setting the stage for the subsequent actions and outcomes.
2. **Perception-Action Loop**: This step involves the ongoing cycle of perception and action, where actions are taken based on the current perception of the situation.
3. **Outcome**: The result of the actions taken within the Perception-Action Loop.
4. **Prediction Error Detection**: At this stage, the outcome is evaluated to detect any prediction errors:
    - **No Error**: If no prediction error is detected, the process loops back to the Perception-Action Loop, allowing for continuous action without reevaluation.
    - **Minor Error**: If a minor error is detected, the action is retried.
    - **Significant Error**: If a significant error is detected, the process moves to the reorientation (including explorative behaviours and MDM).
5. **Retry Action**: When a minor error is detected, the action is retried, looping back to the Perception-Action Loop.
6. **Reorientation**: In the case of a significant error, the situation is reevaluated, and new decisions are made regarding the next steps.
7. **Abandonment**: If the reorientation process indicates a high cognitive load or insurmountable obstacles, the activity is abandoned, concluding the process.

This enhanced flowchart effectively captures the iterative nature of DM, emphasising continuous evaluation and adjustment of actions based on outcomes to achieve the desired goal. The inclusion of a feedback loop for no prediction error scenarios ensures the process remains dynamic and adaptive.

These models provide a visual representation of the core findings and the proposed mechanism discussed in the synthesis. They can serve as a useful framework for understanding MDM in everyday life and can be further refined and expanded based on the insights gained from this research. Nevertheless, they represent an oversimplification of steps that often overlap of loop, depending on the specific circumstances, as shown by our statistics of the sequences.

In the subsequent discussion section, the proposed model will be compared to existing literature, highlighting similarities and differences with established theories such as Rasmussen's model (1983). The chapter will conclude with a broader comparison of the model's general economy to Activity Theory and Installation Theory, underscoring the study's contributions to the field.

6 DISCUSSION

The core findings of our research on MDM in everyday life have uncovered a fundamental mechanism that governs how individuals navigate the complex and dynamic demands of their daily activities. This mechanism, which involves a continuous process of comparing expectations to actual outcomes and employing various strategies in response to disruptions, offers a novel perspective on MDM processes in real-world contexts, one that complements previous models of decision making that were established on different kind of empirical data.

The nature of our data is fundamentally different from that typically used in decision science research. While many studies focus on controlled environments or specific decision scenarios, our research tries to capture the messy, complex reality of DM in everyday life. This difference in data type and collection method naturally leads to findings that may not neatly fit within existing theoretical frameworks.

When we initially started our research, we were agnostic about what a decision is. We thus investigated and described the process by which the action is oriented into one path or another. What we found is that the «decision» is one of the possible paths of that process. Activity is a process of continuous orientation of how we chain successive actions, sometimes seamless (the fluid flow, where orientation is semi-automatic), sometimes following a breach in the flow. 85% of the breaches in the flow led to MDM.

In this chapter, we discuss our findings in relation to existing literature, highlighting the similarities, differences, and specific contributions of our proposed model. We will also explore the implications of our research for theory and practice and identify potential directions for future research.

Throughout the literature review, we have listed a diverse range of theories and scholarly works. To what extent do our findings, grounded in a specific type of data (naturalistic situations, subjective explanations, mundane everyday tasks), resonate with these theories that were grounded on different types of data (e.g., thought experiments in labs, economic decisions, decisions in emergency situations, scenario-based choices, gambling situations, etc.). This is a difficult exercise. First, as highlighted above, the data are very different. Then, it is crucial to acknowledge that some of these theories and scholars may present contradicting viewpoints or stem from different epistemological backgrounds. Our aim, therefore, in employing this broad theoretical lens was not to reconcile these differences to argue for the superiority of any single approach or to try to validate or falsify other theories and models. The very complexity and interweaving of the microscopic processes we found in our material encourage us to remain modest and cautious. Rather, we sought to examine how our unique dataset and findings align or misalign with various existing perspectives on DM.

By testing our observations against various theories, we highlight areas where current understanding effectively explains real-world DM and the areas where it may fall short. This approach allows us to contribute to the field by offering a bridge between theoretical constructs and empirical observations of everyday decision processes in the case of MDM.

In passing, we also mention some convergences or similarities with other models of general psychology and cognitive science beyond the domain of DM literature since activity is determined by many factors, and our perspective here is not only to consider decisions in isolation but rather in the larger context of the activity.

6.1 ACTIVITY COMPONENTS

Our variables were behavioural events that we could use operationally to observe, distinguish, and code our components and sequences (e.g., pause, scan, and hesitation). We are interested in these behaviours because they are indicators of reorientation and micro-decisions, phenomena of interest that, precisely, we want to understand better and for which we started with no specific preconception or model on what they are and how they operate.

These observable behaviours are linked with *components of activity* that are not necessarily observable per se but can be deducted from the analysis of what the participants say about their mental processes during the RIW and the RRIW. By assembling these components, we can create a model of activity, of the reorientations and micro-decisions are part of.

So, each component of the activity model can be seen as part of an “activity system” with its own object, community, and division of labour (Engestrom, 2000). Below, we will analyse each behavioural component and its operational variables and compare it, if possible, to the literature we reviewed in the second chapter of the thesis (see Chapter 2 on Literature Review). Full examples can be viewed in section 4.2.5. Coding and Concepts of the Research Design chapter, in which we explain our coding and concepts.

6.1.1 Activity Initiation

During the RIWs, **initiation of the activity**, as explained by all participants, was by deciding on a general goal and/or a future desired state:

> *"I decided to clean up and tidy up a bit"* ***- P5***.

Whether that goal includes a careful decision on what to prepare for a meal or simply going through a pre-defined routine of certain activities, setting a goal is experienced as making a decision by the actors:

> *"I experience the cleaning part as a decision"* ***- P10***
>
> *"The decision is whether to clean the room or not"* ***- P12***.

Thus, determining the general future-oriented purpose of the activity was described by participants as a conscious decision:

> *"Deciding that I wanted to read at that point was a decision I made" - P8.*

P9 also explained making an explicit decision to *"get it together and get rid of the mess"*. She further explained:

> *"I set a goal of cleaning and decluttering my room"*

and subsequently engaged in the process of reaching her chosen desired state. As described by many participants, an activity typically starts with a conscious decision over a future desired/required state. In Activity Theory, this stage would be seen as the formation of a motive, which is transformed into a goal that initiates the activity (see section 2.9. Activity Theory). P. K. Anokhin's theory of functional systems explains such a decided future state as a "result of a system", which is "a desired relation between an organism and its environment, achieved through the realisation of that system" (2016, p. 272). Therefore, activity is stimulated by a discrepancy between the actor's current state and a mentally simulated future result. The actor decides on such a result consciously, leading to explicit experiences of DM through this future-oriented step of the activity process. So far, activity theory matches very well with what we observed.

From a neuroscientific perspective, "the interaction of neurons while achieving a behavioural result is accomplished by synchronising the activity of the neurons in different brain structures"

(Alexandrov & Shvyrk, 2008, p. 422). This "synchronising" is consistent with our hypothesis of a prediction error control system that would compare the goal to the current state of experience. Therefore, consistent with the participants' explanations, what makes a sequence of actions, tasks, and sub-goals meaningful is the idea of a goal with regard to which the actor perceives the entire process (Alexandrov, 2008). The presence of neuron activation *per se*, as well as the activation characteristics, depend on the actor's chosen goal (Grace et al., 2007). So, the environment is subjectively interpreted by the actor based on a consciously decided future desired state (the goal); that is what enables assessing the relevance of the objects encountered, which are evaluated from the perspective of the activity. This finding sits well with Lomov's (1977) recognition of an activity goal as an ideal representation of the future result of the activity set by the individual himself. Such a notion is consistent with the findings of this research through which actors described explicitly experiencing DM when choosing a goal.

Similarly, our findings also resonate with Nosulenko's notion of the actor's predetermination or predefinition of certain aspects of activity prior to engaging in concrete actions. The chosen goal is a key part of this predetermination. It is in the perspective of this goal that the objects encountered along the way are evaluated and perceived as a "subjective object" ("predmet": предмет), as well as from the previous experience with similar objects. For example, in the activity of cleaning, a cloth can be perceived as a possible object for wiping the table, while in the context of Covid19, it would rather be perceived as an object to disinfect the hands. Predmet involves "... the formation of the activity program, of the ways of achieving the goals... The individual use of an object starts long before any real interaction with it." (Nosulenko & Samoylenko, 2009). The actor mentally simulates and structures key elements of the activity in advance, centred around their envisioned goal state.

Upon deciding over a future desired/required state, the deviation between the actor's current state and the desired one appears to be a stimulant for subsequent actions. Participants experienced a mental simulation of a sequence of goal-oriented actions/tasks as a mental action plan or a road map to reach the pre-decided goal. Consistent with this finding, the term "conceptual model" was adopted by Welford (1961) to interpret such psychic processes. The term has been used to describe the actor's inner world, which is constructed through the accumulation of experience, knowledge and information (Nosulenko et al., 2005).Thus, the actor simulates a mental action plan to achieve a desired future state, while a perceived discrepancy between the current state and the desired one feeds forward and serves as a stimulant for subsequent actions.

The initiation component of our model, which involves setting a goal or intention and beginning to engage in actions directed towards achieving that goal, aligns with various theories of goal-directed behaviour and self-regulation. For example, Goal Setting Theory (Locke & Latham, 1990) emphasises the importance of setting specific, challenging goals in directing attention, mobilising effort, and guiding action. Similarly, the Rubicon Model of Action Phases (Gollwitzer, 1990) proposes that goal pursuit begins with a deliberative phase, where individuals consider their desires and beliefs and form intentions to act.

In the context of Activity Theory (Engeström, 1999; Lahlou, 2024: 20-39), the initiation phase can be seen as the formation of a motive, which is transformed into a goal that directs and energises the activity. This aligns with our findings, where participants described the initiation of an activity as a conscious decision based on a future desired state or goal.

We then observed two distinct types of situations in activity: the flow and breaches of the flow, the latter of which takes several forms.

6.1.2 Fluid Flow

We demonstrated two distinct moments of activity, one fluid, fast, automatic, and easy, and the other one being disrupted. In the first, the "flow", the actions and their succession are fluid, almost automatic (although often conscious). In that state, the participant is very much channelled through the installations and does not need to think consciously of the next action, the situation is conducive to the next action(s) (Lahlou, 2015, 2024). Such regulation was experienced by the participants as a reduction in possibilities for action/task, ultimately leading them into perceiving the activity process holistically and as something *"effortless"* (P1, P18, P24, P56), *"natural"* (P55), *"obvious"* (P8, P19, P40), *"automatic"* (P43) and/or *"normal"* (P18). The participant seems *"in the flow"* of the activity, and the mind is primed while the action at hand triggers the next action(s). For example, P38 explained the preparation process of a meal:

> *"It felt really obvious to put them in the oven for the cooking process. It's a pretty standard, pretty straightforward and effortless meal".*

This is consistent with Installation Theory. There are constantly numerous possibilities and actions that the participant could engage in, but the action currently being done primes the brain, and thus, these other paths that are not in direct continuation are less primed. In other words, the brain is primed by what the participant is doing, and thus, a specific and related set of relevant opportunities and action(s) are triggered and considered, whether consciously or not. We hypothesise that the activity in which the participant is engaged acts as a massive neural attractor, which is why the participant remains indifferent to other attractors in the environment, a bit like someone who is hungry tends to be less attentive to what is not food. Less relevant elements in the context don't seem to trigger action or successfully grab the participant's attention. Such orientation towards the goal occurs continuously as the participant pursues satisfaction.

Although the participants described a mental action plan, not everything that is imagined can occur. The realisation of simulated actions depends on the extent to which the actor's environment can afford their materialisation. In addition to the physical affordances of the environment, the actor's embodied competencies, which include the actor's subjective interpretation of occurrences, previous experiences, knowledge and learning skills, and what is considered as socially appropriate (see section 2.10 on Installation theory), feed-forward into the conceptual action plan. Therefore, such dynamic regulation determines what activity can actually and really occur, guiding and channelling the activity process towards the actor's chosen future state. Strong regulation of behaviour through installations leaves the actor with limited (sometimes one only) possibilities for action, reducing the explicitness of DM over choosing an activity, which can potentially lead the actor into meeting the chosen desired state.

Consistently, in such circumstances of flow, participants reported no explicit experiences of DM, perceiving the channelled activity process as *"obvious"* (P14, P8, P1, P8, P10, P42, P58, P29, P15, P17, P21) through which they simply have to "go with the flow" (P5) of a sequence of emerging actions/tasks which leads to a fluid flow of actions. When such channelling action tunnels are highly fluid, the actor views the entire process for reaching the goal holistically and experiences the goal-oriented sequence of actions/tasks as simply *"knowing what to do"* (P1), for which they do not have to consciously think of. A fluid flow of activity represents the unproblematic execution of an activity, where the individual's actions are in harmony with the tools and rules of the activity system (Engeström et al., 1999). It also demonstrates how activity happens through installations, which are the familiar, socially constructed apparatuses which elicit, enable, scaffold and control activity, making it look like a fluid flow of actions conducted through cognitive tunnels (Lahlou, 2018).

Such fluid activities are often straightforward, simple, and familiar to the participant, as P3 described

> *"much like running for that matter, I just turn off my brain, and there is not much active thinking going on. […] I mean, the whole cleaning thing is amazing because I'm always able to turn off my brain because it kind of somehow happens"*

Fluid flow is a massive resonance of the entire brain throughout a specific activity. Hence, it is seldom distracted or disrupted since everything is very much tuned and in place. We hypothesise this is why becoming distracted or disrupted when you're very much in the flow is tricky, and we see fluid actions in often easy and small tasks. For example, P8 explained the preparation process of a meal:

> *"It felt really obvious to put them in the oven for the cooking process. It's a pretty standard, pretty straightforward and effortless meal".*

Where the fluidity of the installation made the realisation of an activity very convenient, action control rarely occurred through explicit experiences of DM, and the activity process was perceived by participants as "obvious" and experienced as "just happening," indicating some degree of action automaticity.

Therefore, when strong regulation was imposed, consequently narrowing down the range of action into a single possibility, participants perceived the activity/task as *"the go-to option"* (P9) or *"the only option"* (P3), for which they did not have to decide. For example, P6 explained taking a salad bowl from the cabinet:

> *"It wasn't really a conscious decision. I just know that it needs to be a bowl so that I can put water in it to be able to cook the couscous, and that was the only one available so, I didn't really have to think about it".*

On another occasion, P2 described:

> *"I felt like having something savoury so, then in my mind, it was like what do you have which is savoury? So, obviously the only choice is hummus and flatbread because it's the only savoury thing I have".*

Additionally, internal regulation was imposed through "rapid autonomous processes which are assumed to yield default responses" (Evans & Stanovich, 2013) and was experienced by the participants as the "default choice" (P9), which occurred with no experience of DM. For example, P12 explained making the bed immediately after waking up:

> *"It's something that I always do. I just do it without thinking, so I don't experience it as making a decision".*

Therefore, activities perceived as habits and/or routines were described by the participants as happening *"automatically"* (P6) and required little (even none) conscious thinking:

> *"drinking milk has always been how I start my day my entire life. I wouldn't say I felt like I decided to do it"* ***– P12***

Participants explained that when relying on their previous experiences, knowledge, and skills, or more generally, their embodied competencies (see Installation Theory), the occurring activity/task was rarely decided for and was thus mostly experienced as *"something obvious"* (P8) which the actor is somehow aware of. For example, P1 described relying on his previous experiences to resolve an obstruction with a drawer:

> *"It's just obvious. I know how these IKEA things work and I also know how these shelves work".*

Where previous experiences did not exist or were insufficient to feed forward into the realisation of a task to resolve an obstruction, the actor distributed their action (Lahlou, 2017) and/or DM to other people (asking for instructions or help), objects (physical affordances of the environment) and/or installations. For example, P12 explained distributing DM and relying on her mother for instructions on how to prepare a certain meal, following her decision to satisfy her motive of consuming it:

> *"The recipe that I'd decided to make that day was something I've never made before, so I asked my mum how to make it, so she explained the recipe and the instructions".*

This illustrates the social aspect of MDM. For example, Participant 38 explained their cooking process as not having to make any decisions since they only need to simply act on what their girlfriend says:

> *"I'm just acting on [girlfriend's] decisions. She's telling me to take some olives for the [specific meal they are making] because apparently, we need olives for that. I'm mostly just following instructions here, can't say there were decisions, it was more like acting, reacting on here instructions.".*

One relevant connection is the notion of "search image" introduced by the biologist Jakob von Uexküll (1992). According to Uexküll, organisms perceive and interact with their environment based on their specific "umwelt" or subjective perceptual world, which is shaped by their biological needs, sensory capacities, and action possibilities. The idea of a search image refers to the selective attention and perceptual readiness of an organism for specific environmental features or cues that are relevant to its current goals or needs. This concept aligns with our characterisation of fluid flow as a state in which individuals are smoothly guided by the affordances and cues of their environment, expecting what is predicted from their knowledge or past experience while remaining relatively indifferent to irrelevant or distracting stimuli. This expectation is precisely what enables the detection of a prediction error when the perception does not match the expectation.

The fluid flow state can also be understood in terms of the "theory of relevance" proposed by Sperber and Wilson (1986) in the context of pragmatics and communication. According to this theory, human cognition is geared towards the maximisation of relevance, which is defined as the optimal balance between the cognitive effects (i.e., the informational or contextual implications) and the processing effort (i.e., the mental resources required to derive those effects) of an input. The theory posits that humans automatically and subconsciously allocate their attention to stimuli that are deemed relevant to their current goals while filtering out or ignoring those that are not. This perspective aligns with our finding that during fluid flow, participants are selectively attuned to the action possibilities and cues that are relevant to their ongoing activity while being less sensitive to peripheral or unrelated information.

The literature on inattentional blindness (Mack & Rock, 1998b; Simons & Chabris, 1999) provides further support for the idea that attentional processes play a key role in shaping the contents of conscious experience during fluid action. Inattentional blindness refers to the phenomenon whereby individuals fail to notice salient or unexpected stimuli when their attention is focused on a specific task or activity. Numerous studies have shown that under conditions of high perceptual or cognitive load, individuals may miss even highly visible or unusual events if they are not directly relevant to their current goals or expectations (e.g., Simons & Chabris, 1999). This finding resonates with our observation that during fluid flow, participants may be less likely to notice or respond to stimuli that are outside the scope of their current activity, even if they are otherwise salient or significant.

The priming literature in cognitive psychology (e.g., Meyer & Schvaneveldt, 1971; Neely, 1977) provides a potential mechanism for understanding how fluid flow is maintained and guided by environmental and embodied cues. Priming refers to the influence of a prior stimulus or context on the processing of a subsequent stimulus, leading to faster, more accurate, or more biased responses. Studies have shown that priming can occur at multiple levels of processing, from low-level perceptual features to high-level semantic associations and action plans (e.g., Neely, 1977; Schacter et al., 2007) In the context of our model, priming could help explain how the smooth progression of actions during fluid flow is facilitated by the activation of relevant perceptual, cognitive, and motor representations, which guide attention and DM towards the most appropriate or likely options for action.

Finally, the concept of "fluid flow" in our model shares some similarities with Mihaly Csikszentmihalyi's notion of "flow" in positive psychology (2014). Csikszentmihalyi describes flow as a state of optimal experience characterized by intense focus, enjoyment, and a sense of effortless control, often associated with highly skilled performance in domains such as sports, music, or creative pursuits. Both concepts emphasise the smooth, seemingly automatic progression of activity and the subjective experience of being carried forward by the dynamics of the situation. However, it is important to note that the "fluid flow" in our model differs from Csikszentmihalyi's flow in several key respects. While Csikszentmihalyi's flow typically involves a balance between high levels of skill and challenge, leading to a sense of heightened engagement and positive affect, the fluid flow in our model is more closely tied to the motor and perceptual aspects of everyday activities, which may be relatively low in complexity or challenge. Moreover, our concept of fluid flow emphasises the role of environmental affordances, embodied skills, and situational cues in guiding the smooth progression of activity, whereas Csikszentmihalyi's flow places greater emphasis on the subjective experiential qualities of the flow state itself. Thus, while both concepts share a focus on the continuity and smoothness of activity, akin to "surfing on a wave," the fluid flow in our model is more specifically grounded in the motor and perceptual dynamics of situated action rather than the psychological dimensions of optimal experience (Csikszentmihalyi, 1988; Lahlou, 2018; Malafouris, 2013).

6.1.3 Diversion

Despite an otherwise fluid flow of activity, we sometimes see a minor diversion, though the participant quickly returns to the goal pursuit. A small flow is occurring on the side of the main activity flow. Such **diversions** are various ways of doing the same activity without having to change the activity entirely and without facing an intersection or choice. The participant appears to be attempting to orient towards the best possible path towards the goal after evaluating (here, unconsciously) the situation. In such instances, there is no change in intention. The original motive/goal is maintained, but the participant is unconsciously and automatically orienting and slightly rerouting based on a relevant opportunity that has revealed and successively attracted the participant's attention through their heavily primed brain.

This behavioural component describes instances where individuals opportunistically exploit aspects of a situation without disrupting their ongoing flow of activity. It can be observed as an unplanned or spontaneous engagement in a secondary activity related to the primary task that enhances its efficiency without significantly disrupting the main activity flow or requiring a reorientation of goals (e.g., checking the weather while walking, putting music on while cleaning and tidying up while cooking). This is often encapsulated by the thought *"I might as well"* (P1, P40, P17, P21, P16, P2, P28, P31, P58).

This phenomenon can be analysed through the lenses of multiple disciplines. Cognitive psychology might interpret "add-on opportunities" as examples of heuristic processing, where individuals use mental shortcuts to make quick, energy-efficient decisions. According to this perspective, such opportunities are seized because they align with pre-existing mental schemas and do not require extensive cognitive load to process (Tversky & Kahneman, 1974). These actions are consistent with the principle of cognitive economy, which states that people tend to conserve cognitive resources and rely on habitual responses whenever possible (Simon, 1955). Moreover, the design and layout of spaces can make it easier or harder for individuals to engage in efficient behaviours. Spaces that are designed with affordances for multitasking or "add-on" actions can encourage efficient behaviour without additional cognitive or physical burden (Gibson, 1986a). For example, our participants often engage in other activities while Eating or Drinking. We suspect this is because the activity does not use up much of the participant's resources; thus, they engage in other activities and multitask to use more resources.

This phenomenon of "add-on opportunities" or diversions can be better understood through the lens of situated cognition and ecological psychology. We can interpret them as adaptive responses to the affordances present in the environment.

From the perspective of situated cognition (Lave & Wenger, 1991; Suchman, 1987), these "add-on" behaviours emerge from the dynamic interaction between the individual and their environment. Participants are not simply applying pre-existing mental schemas but are responding to opportunities as they arise in the context of their ongoing activities.

Gibson's (1979) concept of affordances provides a useful framework for understanding these diversions. Affordances are possibilities for action that the environment offers to an individual. In our observations, participants often recognise and act upon affordances that align with their current goals or allow for efficient multitasking. For example, P17 described:

> *"I put the food in the microwave and was waiting for it to heat up. It beeps when it's done. I saw the pile of letters there [on the counter] while I was waiting so I thought to have a look and kind of sort them and see which is mine."*

This example illustrates how the participant recognised an affordance (the pile of letters on the counter) that aligned with their overall goal of maintaining a tidy kitchen and acted upon it within the constraints of their primary task (waiting for the food to warm up).

The frequency of these diversions during activities like eating or drinking can be understood not just as a result of these activities requiring fewer cognitive resources but also as a response to the specific affordances present during these activities. For instance, P32 noted:

> *"When I'm having my morning coffee, I often check my emails. The coffee mug is right there, and my phone is usually nearby. It feels natural to do both at the same time."*

This description highlights how the spatial arrangement of objects (coffee mug, phone) and the nature of the primary activity (drinking coffee) create affordances for multitasking.

The principle of "add-on opportunity" highlights an inherent desire for efficiency in human behaviour, allowing individuals to maximise their efforts with minimal expenditure of resources. We identified such minor breaks in the activity flow as diversions (as opposed to Disruptions), which do not require reorientation by the actor as the fluidity of activity is not massively breached, so much so that it requires reorientation which is accompanied by experiences of MDM. We observe these instances as minor shifts and diversions in the activity course which is due to participants' desire to maximise the use of mental and physical resources to achieve satisfaction and efficiency.

P2 explained:

> *"[I went to the table] to take the plates, but I also change the music because I'm already there, so I thought I might as well, and then I go for the cabbage [in the fridge]."*

Such opportunities are often with the intention of saving physical and cognitive resources and often require very few such resources without the necessity to reassess the situation. In other words, the participant keeps on the same main track but does something slightly different to the action. Here, they are not facing an interruption or an intersection in the process. Additionally, as long as the task at hand is easy and small, the brain can handle more attractors in addition to the main one, which also happens to prime the brain. So, if the participant thinks they can handle another attractor, they engage in a minor "add-on" action.

Participant 1 gave an example of an add-on opportunity while he was cleaning, explaining:

> *"I really like fresh air so, like, while I'm cleaning, might as well add in some fresh air."*

In a similar vein, and in the context of everyday activities, almost all participants explained trying to maintain some degree of efficiency within the tasks and activities in which they engaged. Such efficiency mostly occurred in two ways. One manifested as the actor's attempt to increase the speed of DM and consequently the following task and/or activity:

> *"It's just the shortest way to get to the tube station and I just want to get to uni as soon as possible, so I just take the shortest route"* ***- P4.***

The second way to maintain efficiency occurred through reducing the physical and/or cognitive effort invested by the actor in making decisions and reaching future desired/required state(s):

> *"I'm running around sweaty for like a very long time now, and I also realised, I could have showered but, you know, I might as well streamline the activities"* **– P1.**

In the same spirit, P11 explained:

"I just only take the time to respond to all the notifications all together, because I think that saves a lot more energy than constantly opening social media to just reply to one person or message".

Additionally, participants sometimes mentioned trying to *"save time"* by getting done with some other (usually related) tasks should the task at hand require them to wait for its completion. An illustrative example was P12's description of how she avoided having to wait passively for the completion of a(n) task/activity:

"I'm waiting for the milk to warm up, and meanwhile, I'm tidying up the kitchen. [...] The vegetables were already cooking and I just had to wait, I was trying to think of anything I could do in the meantime".

From our transition analysis (see Research design), we found that diversions always lead to a continuation of an activity and never experienced a s disruption or something that participants had to decide or think too much over.

The concept of diversion in our model, which represents a temporary departure from the main course of activity to address a secondary goal or opportunity, can be seen as a way for individuals to optimise their actions and maximise their outcomes without significantly disrupting the flow of their primary activity. This notion of diversion as an opportunity for "add-ons" or "side-tracks" that enhance the efficiency or value of an activity is consistent with various theoretical perspectives and empirical findings in the literature.

One relevant connection is the idea of "opportunistic planning" in the context of intelligent systems and human-computer interaction (Hayes-Roth & Hayes-Roth, 1979; Suchman, 1987). Opportunistic planning refers to the ability of an agent (whether human or artificial) to flexibly adapt its goals, plans, and actions in response to the changing demands and affordances of the environment. Rather than strictly following a predefined sequence of steps, an opportunistic planner is able to recognise and exploit new opportunities for action as they arise while still maintaining the overall coherence and direction of the activity. This perspective aligns with our characterization of diversion as a moment where individuals spontaneously deviate from their main course of action to address a secondary goal or incorporate an additional task without losing sight of their primary objective.

The concept of diversion as an add-on opportunity can also be understood in terms of the "marginal value theorem" (Charnov, 1976) in behavioural ecology. This theorem posits that foraging animals should optimize their time and energy allocation across different patches of resources based on the marginal rate of return (i.e., the additional gain in resources per unit of time spent in a patch). The theory predicts that animals should leave a patch when the marginal rate of return falls below the average rate of return across all patches. In the context of our model, diversions can be seen as a way for individuals to maximise the marginal value of their actions by opportunistically switching to a secondary activity or resource patch when the returns of the primary activity are momentarily diminished or when the opportunity costs of not pursuing the secondary goal are perceived as high.

The notion of diversion as an add-on is also related to the concept of "prospective memory" in cognitive psychology (McDaniel & Einstein, 2000). Prospective memory, with its emphasis on salient cues, refers to the ability to remember to perform an intended action in the future, often in response to a specific cue or context. Studies have shown that individuals are more likely to successfully execute a prospective memory task when the cue is salient, distinctive, and semantically related to the intended action (e.g., McDaniel & Einstein, 2000). In the context of our model, diversions can be seen as a form of event-based prospective memory, where the presence of a particularly salient environmental cue or opportunity serves as a trigger for initiating a secondary task. The fact that participants often reported noticing and acting upon these opportunities without significantly disrupting their primary goal suggests that the prospective memory processes underlying diversions are relatively automatic and well-integrated with the ongoing flow of activity.

Finally, the idea of diversion as an efficient and non-disruptive way of managing multiple goals and demands is consistent with the literature on "multitasking" and "task switching" in cognitive psychology and human factors (e.g., Monsell, 2003; Salvucci & Taatgen, 2008). While much of this literature has focused on the costs and limitations of multitasking, such as the "switch costs" associated with shifting between different tasks or mental sets (Monsell, 2003), some studies have also highlighted the potential benefits of strategic and well-timed task switches for maintaining performance and reducing boredom or fatigue (e.g., Salvucci & Taatgen, 2008). In the context of our model, diversions can be seen as a form of "micro-task switching" that allows individuals to briefly engage with a secondary task or goal without incurring significant switch costs or disrupting the overall flow of the primary activity. This underscores the potential benefits of diversions in enhancing performance and reducing monotony.

Participants appear to take in as much as they “feel” they can handle. Such an attempt to act efficiently and optimise resource use is rooted in human beings' evolutionary aspects. This notion of diversion as a means of "streamlining" or "using up" available resources is consistent with the idea that human beings are "cognitive misers" (Fiske & Taylor, 1991) who seek to minimize the expenditure of mental effort and achieve their goals with the least amount of cognitive exertion.

The cognitive miser perspective suggests that individuals have limited cognitive resources and are motivated to conserve these resources by relying on simple, efficient, and heuristic strategies for processing information and making decisions (Fiske & Taylor, 1991). This perspective is rooted in the broader framework of "bounded rationality" (Simon, 1955), which posits that human cognition is constrained by various limitations, such as working memory capacity, attentional focus, and processing speed, and that individuals often seek to satisfice rather than optimise their outcomes based on these constraints.

In the context of our model, diversions can be seen as a way for individuals to efficiently utilise their available cognitive and physical resources by opportunistically engaging in secondary activities or goals when the demands of the primary activity are momentarily reduced or when the opportunity costs of not pursuing the secondary goal are perceived as high. By strategically shifting their focus to a side-track or add-on task, individuals can maximise the overall productivity and value of their actions without incurring significant cognitive costs or disrupting the flow of the primary activity.

The idea of diversion as a manifestation of cognitive miserliness and efficiency-seeking is consistent with the broader evolutionary and ecological perspective on human cognition and behaviour (e.g., Gibson, 1979; Gigerenzer & Todd, 1999). This perspective emphasises the adaptive fit between the cognitive strategies and heuristics employed by individuals and the structure and demands of their natural environments. In a world of limited resources and competing demands, the ability to flexibly and efficiently allocate one's cognitive and physical resources across multiple goals and opportunities may confer significant advantages for survival and reproduction. From this perspective, diversion can be seen as an evolved and ecologically rational strategy for optimising the use of available resources and maintaining a balance between the exploitation of known opportunities and the exploration of new possibilities.

The concept of diversion as an opportunity for add-ons or side-tracks that enhance the efficiency or value of an activity is consistent with various theoretical frameworks and empirical findings in the literature, including opportunistic planning, marginal value theorem, prospective memory, and multitasking. This enriches our model with potential explanations. Indeed, following the idea of multidetermination of behaviours, what we observe may not have one single cause but perhaps several, together or alternatively, depending upon the circumstances. What is reassuring here is to see that the mechanisms that we have observed and described in MDM seem to have been observed, by different researchers and with other types of material. The generic idea is that, under some conditions, a given behavioural track can be continued while being added opportunistically a second, minor track that exploits the local possibilities to provide some added benefit at a low cost.

By situating our model within this broader interdisciplinary context, we can gain a more nuanced and integrative understanding of how individuals strategically and adaptively navigate the multiple goals, demands, and opportunities that arise in the course of their everyday activities. The fact that participants in our study frequently reported engaging in diversions without significantly disrupting their primary objectives suggests that these brief departures from the main course of action may serve an important function in optimising the allocation of cognitive and physical resources and maintaining the overall coherence and productivity of the activity. As we continue to refine and extend our model based on new data and insights, the concept of diversion as an add-on opportunity may provide a valuable lens for understanding the dynamic and flexible nature of goal-directed behaviour in everyday life.

If minor diversions become too disturbing and the changed situation is massively different from what the participant was expecting, it becomes a disruption, leading the participant to recalculate or restabilise the activity.

6.1.4 Disruption

In that state, the action is interrupted by some external interruption or accident or by the actor herself. We have coded these as breaks in the flow, which can come with various degrees of severity.

Interestingly, participants explained sometimes having to *"decide against"* (P1, P24, P51) a habit and/or a routine which normally happened with some degree of automaticity. Therefore, as a "default" activity/task emerged, choosing to act otherwise was experienced by participants as an explicit MD to intervene with the automatic flow of habits and/or routines. We classified this as an internal disruption (see Disruption) in the activity flow. For example, P1 described his thought process for deciding against his habit of washing hands after touching a dirty broom:

> *"Normally, I would wash my hands, but I realised that I don't really need to wash them anymore because I'm not handling anything that is clean or crucial. So, I guess washing hands is just more of a habitual response than it is conscious, so I decided against it".*

This has occurred due to the participant self-disrupting their otherwise automatic and fluid flow of actions.

This component, characterised by internal and external interruptions that challenge the ongoing flow of activity, offers a rich vein for transdisciplinary analysis. We observe such disruptions occurring either due to an internal cue (self-disruption) or disrupted by a cue from the actor's external environment. Disruptions force a pause, hesitation or scan, meaning they necessitate a (re)orientation, whether it be adaptation, reevaluation, or abandonment of the current course of action. Therefore, a self-disruption is an interruption in the ongoing flow of an activity caused by an internal cognitive or emotional cue (an environmental or social cue causes external interruption) that forces the individual to pause, hesitate, or scan their environment, requiring a reassessment or adjustment of the current task. Disruptions are conflicts or contradictions within the activity system, which may arise from misalignments between the elements of the system, such as tools, rules, community, or division of labour (Bakhurst, 2009). Activity Theory considers disruptions as contradictions within or between the components of an activity system (Engeström, 2000).

Internal disruptions might be seen as contradictions within the individual's motives or between the individual and the community rules, while external disruptions are contradictions arising from the interaction with the physical and social environment. Disruptions occur when activity is no longer regulated strongly by the installation and can be analysed and understood as a loss of coupling between the individual and their environment. They can also be viewed as changes in these installations that necessitate behavioural adjustments (Lahlou, 2018). Internal disruptions might involve changes in personal beliefs or attitudes, while external disruptions involve changes in the physical or social cues that guide behaviour.

Applied psychology and social psychology might view disruptions as moments requiring problem-solving and resilience, invoking the need for adaptability and potentially leading to stress or decision fatigue (Muraven et al., 1998). Disruptions may be due to a perceived problem or obstruction in the activity flow. In cases where an obstruction was perceived, such a decision may be to abandon a task due to an unresolved obstruction or distribute action and/or DM to an external source (objects, installations, or others). If the actor is provided with the pre-decided goals and sub-goals extrinsically (e.g., through instructions), the goal is to “zero in” (Nosulenko et al., 2005, p. 376) on the tasks and tick them off one by one as precisely as possible. Consistent with this concept, the participants described such a process as *“following instructions”* (P9), through which they did not experience having to make a decision but were merely *“acting on a set of pre-decided tasks”* (P12). The actor then simply monitors the outcome by constantly comparing it to the required state/image.

A massive breach in the flow of activity, whether for internal or external causes, disrupts the activity, leading the participant into an intersection where they need to rethink the following action(s). This calls for restabilising and recalculating the attractor and orienting towards the goal. We observe this in our data through long pauses and frequent head movements, which indicates scanning the situation and environment and exploring the possibilities. We believe that in such instances, the participant is looking for affordances, and that is confirmed by the RIW. This will lead to another intersection in which the participant must decide whether to abandon the goal pursuit or change the activity while still pursuing the goal. In other words, the participant is not doing the same activity as before but is still pursuing the same goal.

We find that the participant does not consider the possibility of entirely stopping an activity until the flow is disrupted. The possibility of abandonment can also be considered, and perhaps the activity is abandoned if pursuing the goal is *“not worth it”* anymore. This requires thinking and calculation.

While the environment causes an **external disruption**, a **self-disruption** occurs by the actor. We observe external disruptions as either a distraction due to an environmental cue (e.g., the participant heard something, saw something, smelled something, etc.) or simply because the environment was not conducive to the following action(s) and could not physically afford them. This, in turn, requires the participant to reorient towards the goal. If such orientation occurs without a problem and the participant maintains sufficient motivation, then the goal pursuit can continue, though we see a complete change in the activity. If not, then the activity is abandoned either via making a micro-decision to abandon or simply due to an avoidance of MDM (see Give up below).

Self-disruptions can, and often do, include proactive self-distractions, procrastination, short breaks from an activity, and other instances that indicate a lack of sufficient motivation from the participant. We suspect substantial amounts of computation and calculation going on when the activity flow is disrupted for the participants to orient themselves again towards the goal. In cases where the participant fails to identify any possibilities for action or affordances, they then appear to engage in a problem-solving endeavour requiring their creativity, skills, and past experiences to solve. We frequently observe such endeavours when the participant is faced with a situation for the first time or is very unfamiliar with the situation. We then observe a process of manipulating the environment (moving, examining objects) to solve the problem, or as the participants explain themselves, *"figure out"* the situation as they orient themselves towards the goal.

Intersections throughout the activity process where the flow of the activity is massively breached and thus disrupted require thinking and rerouting while trying to figure out the following action(s), assuming that the activity is not abandoned. We found that maintaining an orientation towards the goal requires some subjective and conscious micro-decisions from the participant, and we operationally saw these reorientations through pauses, hesitations, scans and abandonment of the activity altogether.

The disruption component of our model, which represents a significant breach or interruption in the flow of an activity that requires a reassessment of goals and strategies, can also be understood through the lens of theories of self-regulation and cognitive control. For example, the "breakdown" concept in Activity Theory (Bødker, 1991) suggests that disruptions occur when there is a mismatch between the individual's goals and the resources or constraints of the activity system.

Disruptions can also be understood through the lens of Dual Process Theory (Kahneman & Frederick, 2002), which suggests that individuals shift from automatic, heuristic processing (System 1) to more controlled, analytical processing (System 2) when faced with unexpected or challenging situations.

The disruption component in our model can also be understood through Rasmussen's Skills, Rules, and Knowledge (SRK) framework (Rasmussen, 1983). This framework provides a valuable perspective on how individuals respond to disruptions in their activities, particularly when the usual flow of action is breached.

According to Rasmussen's model, human performance can be categorised into three levels:

1. Skill-based level: This involves highly practised, largely automatic behaviours that require little conscious attention. In our context, this aligns with the fluid flow of activity where micro-decisions are often not consciously experienced.
2. Rule-based level: This involves following stored rules or procedures to respond to familiar situations. When a disruption occurs, individuals may first attempt to apply known rules or strategies to resolve the issue.
3. Knowledge-based level: This is the most cognitively demanding level, involving conscious problem-solving and DM in novel or complex situations.

When applied to our observations of disruptions in everyday activities, Rasmussen's framework suggests a hierarchical escalation in cognitive engagement as individuals encounter obstacles:

1. When the skill-based performance (our fluid flow) is disrupted, there is typically an escalation to the rule-based level. This could perhaps manifest as our observed "retry" behaviour, where participants attempt to apply familiar strategies to overcome the disruption.
2. If rule-based approaches fail to resolve the disruption, there is a further escalation to the knowledge-based level. This aligns with our observations of more explicit MDM processes, where participants engage in conscious deliberation, as evidenced by pauses, hesitations, and scanning behaviours.

This escalation process explains why not all disruptions lead immediately to conscious DM. Minor disruptions might be resolved at the rule-based level without requiring extensive cognitive resources. However, more significant or persistent disruptions necessitate escalation to knowledge-based performance, resulting in the conscious micro-decisions we observed.

Rasmussen's framework thus provides a theoretical underpinning for understanding the varying levels of cognitive engagement we observed in response to disruptions, from automatic retries to more deliberate DM processes. It helps explain the spectrum of responses to disruptions in everyday activities and supports our findings on the context-dependent nature of MDM. Nevertheless, in our specific material (micro-decisions), the differences between the second and third levels of Rasmussen’s model are not obvious. Perhaps the model fits better in more complex situations.

6.1.5 (Re)Orientation

The reorientation component of our model, which involves a process of gathering information, exploring options, and making judgments to navigate a disruption and regain a sense of direction or purpose, can be seen as a form of "metacognitive control" (Flavell, 1979) or "executive functioning" (Diamond, 2013). These concepts refer to the higher-order cognitive processes that enable individuals to monitor and regulate their thoughts, emotions, and actions in the service of goal-directed behaviour. The reorientation component aligns with research on the prefrontal cortex's role in supporting flexible, adaptive behaviour in the face of changing circumstances (Miller & Cohen, 2001). This is where we observe (and participants say) there is a change of subgoal. But we also include instances where there is no change of subgoal but clues that there is an orientation phase, visible through pause or some other breach in the flow; sometimes this leads to reorientation, sometimes not.

The reorientation process can also be understood through the lens of the "orientation gap" concept in Installation Theory (Lahlou, 2017), which suggests that individuals experience uncertainty and disorientation when their expectations or habits are disrupted and they need to find new ways of acting. This aligns with our findings, where participants described reorientation as a process of *"figuring out"* (P1, P59) or *"deciding what to do"* (P6) in response to disruptions.

Dual-process theories, such as the one proposed by Evans and Stanovich (2013), delineate between intuitive (fast) and analytical (slow) thinking. (Re)orientation blends these processes, suggesting that individuals can rapidly engage in analytical thinking when required by a situation, which may not be entirely captured by the dichotomy proposed by Dual-process theories.

In the context of our findings on (re)orientation and choice of alternatives in MDM, Gigerenzer and Goldstein's (1996) recognition heuristic provides a useful framework for understanding how individuals navigate familiar and unfamiliar options in everyday situations. The recognition heuristic posits that when faced with a choice between two options, one of which is recognised and the other is not, people tend to infer that the recognised option has a higher value on the criterion of interest. In our observations of MDM in everyday activities, this heuristic aligns closely with the feed-forward processes we've identified in channelled states of activity. For instance, when a participant encounters a familiar decision point in their activity (such as choosing a specific utensil for a cooking task), the recognised option often coincides with what was "predicted" or expected in the feed-forward process. This alignment between recognition and expectation can explain why many of these choices are not experienced as decisions by our participants despite objectively involving a selection between alternatives.

However, when the feed-forward process is disrupted (for example, when the expected utensil is not available), the individual is forced into a state of conscious DM throughout their reorientation process. In these moments, the recognition heuristic may still play a role, but it interacts with other factors such as the immediate context, past experiences, and the individual's goals. This interaction is evident in cases where participants reported experiencing a decision specifically because they had to choose between a familiar (recognised) option and an unfamiliar one. For example, Participant 39 described such a situation while cooking:

> *"I usually use that pan for frying because of, um, the size; it's ideal for the portion of food that I often take, but actually, I notice there it was dirty after scanning and then, so, basically. I had to decide between washing it or using this new non-stick pan I've never used before, and because the usual pan was really oily from last night's dinner, it wasn't, um, the most convenient option, I guess."*

This example illustrates how the recognition heuristic (favouring the familiar pan) interacts with contextual factors (the pan being dirty) and competing goals (ease of use versus time efficiency), resulting in a consciously experienced decision.

By considering the recognition heuristic in our analysis of orientation and choice in MDM, we gain insight into how individuals navigate the tension between familiar, expected paths of action and novel or unexpected situations. This perspective helps explain why some choices in everyday activities are experienced as automatic and effortless while others require more deliberate consideration.

Finally, NDM emphasises the role of experience and the ability to recognise patterns in complex, real-world situations (Klein, 1993). While (re)orientation fits within the naturalistic DM framework, it also highlights that decision-makers can and do step outside of pattern recognition to creatively and strategically address novel situations.

In sum, (re)orientation presents a dynamic view of DM that incorporates both intuitive and analytical elements, emphasising the role of adaptability and the capacity to swiftly pivot strategies in response to change.

Our identified indicative behaviours are external manifestations of such instances, which we believe accompany subjective experiences of MDM. In other words, our research shows that when the flow of activity is internally or externally disrupted, and the fluidity of the chain of actions is seriously breached, reorienting towards the (sub)goal and/or to the new circumstances generates explicit experiences of MDM. Our behavioural variables are cues to identify such instances and are essentially how instances of reorientation manifest in our data.

6.1.6 Shift

The shift component of our model, which represents a change in the focus or direction of activity in response to a disruption or reorientation process, can be seen as a form of "adaptive action" (Gollwitzer, 1999) or "strategy shift" (Pintrich, 2000) in the face of changing circumstances. The shift component also resonates with the notion of "pivoting" in the entrepreneurship literature (Ries, 2011), which suggests that successful entrepreneurs are able to quickly adapt their strategies and business models in response to new information or challenges. This aligns with our findings, where participants described shifts as moments of *"changing focus"* (P34) or *"moving on to the next step"* (P59) in response to disruptions or new opportunities.

The shift component can also be understood through the lens of cognitive flexibility theory (Scott, 1962), which suggests that individuals who are able to flexibly switch between different modes of thinking and acting are better able to adapt to novel or complex situations. This resonates with our proposal that the ability to smoothly transition between different levels of MDM (strategic, tactical, operational) is a hallmark of adaptive DM in everyday life.

A shift in activity can be analysed through various theories in decision science. Initially, it might seem aligned with the Dual-Process Theory (Evans & Stanovich, 2013), which suggests that DM operates on both intuitive (tactical) and reflective (strategic) levels. This shift could represent the transition from fast, intuitive responses to more deliberate, strategic planning. However, it can also be seen as somewhat contradictory to the principles of Dual-Process Theory, which posits two "systems" of thought: System 1, which is fast, automatic, and often subconscious, and System 2, which is slower, more deliberate, and conscious (Kahneman, 2011). Dual-process theory, if taken too literally, frames DM as a dichotomy between these two systems[3], while the shift stage suggests a more integrated and fluid process.

Strategic decisions are typically associated with System 2 processing due to their complexity and the need for conscious deliberation. Yet, in the shift stage, individuals may quickly adapt their strategies in response to changing circumstances without extensive conscious deliberation, suggesting a more System 1-like process at a strategic level. Tactical and operational decisions, especially motoric ones, often require quick, on-the-spot, Gestlat-based judgments that Dual-Process Theory would categorise under System 1. The shifts that we observe sometimes suggest that these "decisions" can also be informed by a level of reflection and conscious awareness more akin to System 2 processing. To illustrate the blend of System 1 and System 2 processing in the shift stage, Participant 29, while cooking dinner, encountered a situation that demonstrates this blend:

> *"I was following my mother's recipe for the pasta sauce, but when I opened the cupboard, I realised I was out of tomato paste. Without much thought, I immediately grabbed a can of diced tomatoes as a substitute – that was pretty automatic. But then I paused, realizing this change might affect the consistency. I spent a moment considering how to adjust the recipe: should I simmer it longer? Add some tomato ketchup for thickness? I quickly weighed these options, thinking about how each might impact the flavour and cooking time. I decided to simmer it longer and add a bit of ketchup, adjusting other seasonings accordingly. This whole process of adapting the recipe happened in just a few seconds, but it involved both quick, instinctive substitution and a brief but conscious evaluation of the consequences."*

This blending of fast, automatic thinking with reflective, deliberate thinking in the shift stage suggests that the boundaries between System 1 and System 2 are not as rigid as the clear-cut version of Dual-Process Theory implies. It suggests that the cognitive processes underlying DM are more dynamic, multi-level and context-dependent than the two-system model fully accounts for.

So, comparing this with DM research, the shift stage encapsulates the multi-level nature of DM observed in various contexts, from individual to organisational. It aligns with the NDM framework, which recognises that decisions are often made in complex, real-world

[3] Nevertheless, Stanovich and West provide a nuanced version of the Dual Process theory, and the two processes should be more seen as extremes of a continuum.

environments where individuals rely on their expertise and the context to make judgments without a formal analysis of alternatives (Klein, 2008). NDM describes how people make decisions under conditions of uncertainty, time pressure, and high stakes, emphasising experience and intuition over formal analytical methods.

However, the shift stage suggests a more dynamic and less linear approach to DM than NDM typically accounts for. While NDM involves adapting to changing circumstances, the shift stage implies a more rapid and frequent transition between different levels of DM (strategic, tactical, and operational) than NDM may traditionally describe. Although NDM acknowledges that decision-makers can operate at different levels, this stage indicates a seamless integration of these levels that may not be fully captured by naturalistic DM. This challenges the notion that decisions are primarily made based on pattern recognition and intuition without the need for conscious, analytical thought.

Additionally, DM research has shown that decision-makers often satisfice, selecting the first workable option rather than searching for the optimal one (Simon, 1955). The shift stage, however, suggests a willingness to reevaluate and potentially change goals and strategies, which may involve more extensive deliberation than NDM's emphasis on quick, experience-based decisions. Finally, while NDM suggests that in complex situations, decision-makers rely heavily on their expertise and tacit knowledge, the shift stage implies that there may also be a role for more explicit, conscious analysis in shaping or reshaping the course of action. This could be seen as aligning more closely with traditional DM models.

Therefore, while this stage of our model can complement NDM by highlighting decision-makers' flexibility and adaptability, it also suggests that DM can involve a more complex interplay of different cognitive processes than naturalistic DM might traditionally emphasise. These processes, at our scale of resolution through observation and replay interview, appear to run in parallel or to blend rather than alternate clearly. Perhaps a finer time resolution would show these processes alternate very fast, which would support the hard version of Dual-Process Theory, but our data cannot solidly support this hypothesis.

Overall, our findings suggest a more nuanced view of DM in naturalistic settings than some existing theories propose. While our observations don't entirely align with the idea that decisions in such contexts are predominantly intuitive and based on pattern recognition, they also don't fully support a clear separation between System 1 and System 2 processes, at least in the context of MDM. What we observe is closer to Lahlou's notion of a "channelled state", where the orientation is distributed over the subject and her environment; nevertheless, this notion of channelled state has not been clearly operationally described in terms of subjective decision processes.

6.1.7 Continue (Perform Next Action)

The “Continue” component of our model, which involves performing the next action and persisting with the current course of activity after a disruption or reorientation, aligns with various theories of self-regulation and goal pursuit. For example, the "implementation intention" (Gollwitzer, 1999) concept suggests that individuals are more likely to persist with a course of action when they have formed a specific plan for how to respond to potential obstacles or distractions. Similarly, the "action control theory" (Kuhl, 1984) proposes that individuals who are able to maintain a focus on their goals and suppress competing tendencies are more likely to persist in the face of challenges.

This component can also be understood through the lens of the "regulatory focus theory" (Higgins, 1998), which suggests that individuals with a "promotion focus" (oriented towards growth and advancement) are more likely to persist in the face of setbacks than those with a "prevention focus" (oriented towards safety and security). This resonates with our findings, where participants described continuing as a process of *“keeping going”* (P18) or *“staying on track”* (P34) in the pursuit of their goals.

This component of our model represents the persistence or resumption of activity after various types of interruptions or decision points. This continuation can occur in two main scenarios:

1. After a retry: When a minor obstacle is encountered and overcome through a simple repetition of the action, the activity continues without significant cognitive effort or reorientation.
2. After reorientation: Following a more substantial disruption that requires reassessment and possibly a micro-decision, the activity continues along a potentially modified path.

In both cases, "Continue" signifies the maintenance or resumption of goal-directed behaviour. However, the cognitive processes involved may differ. After a retry, continuation is often automatic and seamless. In contrast, continuation after reorientation may involve a more conscious effort to implement a new or adjusted strategy.

Activity Theory would analyse both scenarios as part of an ongoing activity system, where the subject, object, and community continue to interact with mediating artifacts (tools, signs, rules) to achieve desired outcomes (Engeström et al., 1999). The key difference lies in the potential reconfiguration of these elements after reorientation.

Installation Theory (Lahlou, 2018) provides insight into how environmental cues or "installations" guide behaviour in both scenarios. These installations may facilitate smooth continuation after a retry by providing familiar affordances. After reorientation, they may offer new affordances or prompts that support the adjusted course of action.

This dual nature of "Continue" in our model reflects the complexity of real-world activities, where individuals must navigate both minor hiccups and more significant disruptions while maintaining progress towards their goals. Understanding these nuances is crucial for a comprehensive view of MDM in everyday contexts.

This component sometimes involves persisting with the current course of action. This can happen after a retry or after the reorientation has taken place (Engeström et al., 1999).

Installation Theory suggests that behaviour is guided by the environment's cues or “installations” (Lahlou, 2018). These installations, which may include the physical setup, social norms, or other external cues that guide behaviour, could influence the decision to continue with action by providing some feed-forward, e.g., in the form of affordances suggesting action or prompts from other participants.

This stage represents the stabilisation of a new pattern within the activity system, where the subject continues the activity with a possibly revised strategy or method. Neuroscience links the continuation of activity to reward-related processes, possibly involving dopaminergic pathways that reinforce the continuation of rewarding activities (Schultz, 2000).

When individuals feel autonomous, competent, and related to others in their actions, they are more likely to continue. NDM suggests that experienced decision-makers are adept at making adjustments and staying the course in complex, real-world situations (Klein, 1993). The continuing stage in the NDM context would likely involve ongoing pattern recognition and situational awareness, ensuring that continuation is still the best course of action (Endsley & Garland, 2000a).

6.1.8 Identify Possibilities

Operationally, "Identify Possibilities" refers to a crucial stage in the activity process that occurs after a disruption in the flow of activity. This stage is part of the broader MDM process, which can be broken down into several steps:

1. Awareness of the necessity for reorientation: This is triggered by a prediction error, where the expected outcome of an action doesn't match the actual outcome.

2. Problem seizing: The actor recognises there's an issue, such as a lack of clear affordances or too many potential action affordances that correspond to the prediction.

3. Exploration and identification of possibilities: This is where "Identify Possibilities" occurs. It involves both internal and external processes:

- Internal: The actor mentally simulates various potential courses of action.
- External: The actor scans the environment to recognize available affordances.

"Identify Possibilities" is distinct from identifying affordances. Possibilities are internal constructs (potential actions to perform or affordances to search for), while affordances are external features of the environment that offer action possibilities. For example:

> *"I didn't know what to do with that coffee pod. I'm looking at the bottom and sides to see if there are any signs and what I can do with it [keep or throw away]"* ***- P59***

In this case, the MDM process starts after *"I didn't know what to do with that coffee pod"* (awareness of reorientation and problem seizing). The "Identify Possibilities" stage begins with "I'm looking at the bottom and sides," where the participant explores and considers potential actions.

Following the identification of possibilities, the actor may then search for corresponding affordances in the environment that match these potential actions. This process of exploration, identification of possibilities, and search for affordances forms the core of the MDM process, which ultimately leads to a decision and the continuation of the activity.

In this example, the participant is identifying possibilities (recycling, keeping or throwing away the coffee pod) based on the affordances in the environment (signs on the pod). This component aligns with the notion of affordances (Gibson, 1979) - the action possibilities provided by the environment. The findings suggest that after a disruption, actors either directly scan the environment to identify these affordances, which then guide their subsequent actions, or they explore possibilities internally to consider possible avenues of action, eventually helped by external support as here, and then explore the environment to see if the corresponding affordances are available within reach. After examining the coffee pod, Participant 59 continued:

> *"I realise there were no [recycling] symbols and info [instructions] so I put it to keep aside for now and ask [roommate] later if he knew anything about that. So, I put it there [on the counter near the sink] to ask about that later."*

This illustrates how the identification of possibilities (recycling, keeping, or throwing away) led to a decision (keeping it temporarily) and a plan for further action (asking the roommate).

Another clear example of internal reflection followed by external search comes from P19, an example already seen where P19 was trying to stop a washing machine because they had forgotten to include all the clothes that required washing. As a result, they needed to stop the washing machine to add more clothes. Figure 14 on page 91 is the same situation illustrated through thumbnails from the subcam footage. Before the participant engaged in retrying (in Figure 14), they explained:

> *"I want to stop the wash [cycle] to add one cloth I forgot and I'm looking for stop button. There is scanning; it looks like pause, but I'm scanning because I'm looking at the [control panel on] top, at all the buttons. And then I find it and I retry, I think, three times to stop the washing [cycle]."*

When retrying fails to stop the cycle and unlock the washing machine door, the participant then asks their roommate for a solution. Let us transcribe the conversation again:

> ***Roommate:*** *[00:09:27] No, you cannot open it.*
>
> ***Participant 19:*** *I did open it last time. I forgot to put one of my clothes into the washing machine.*
>
> ***Participant 19:*** *[00:09:45] I think this time it would work.*
>
> ***Participant 19:*** *[00:10:20] Do you think it's starting to wash?*
>
> ***Roommate:*** *[00:10:25] I don't know; I suggest you restart [the washing machine].*

The participant then moves to the control panel and scans again to find the on/off button for the washing machine:

> *"I'm trying to find the button for [washing] machine."*

In this case, we can clearly see the stages of MDM:

1. Awareness of reorientation: Realising the need to stop the wash cycle.

2. Problem seizing: Recognising that the location of the stop button is unknown on the control panel.
3. Exploration and identification of possibilities:
    - Internal: Mentally recalling possible locations for the button (we see this through the participant moving their finger through the buttons as they are scanning).
    - External: Scanning the control panel and finally identifying the washing machine button, which is indicated with a label. We can also see that the participant explored external embodied sources with the questioning of the roommate.

This example vividly demonstrates how the participant first engaged in internal reflection to generate possibilities, then systematically searched the environment to find the corresponding affordance (the on/off button).

These examples highlight the interplay between internal cognitive processes (identifying possibilities) and external exploration (searching for affordances) in MDM. They show how individuals navigate unfamiliar or challenging situations by drawing on both their internal knowledge and the external environment to solve problems and make decisions.

This also resonates with the situated nature of cognition (Hollan et al., 2000; Lave, 1988; Suchman, 1987). The findings suggest that MDM in everyday activities heavily relies on the actor's ability to perceive and utilise affordances in the environment, underlining the situated and embodied nature of cognition, and that, as described by situated cognition, automatic reaction with embodied skills primes the reliance on plans, which are considered if the former fails to satisfice.

In Activity Theory (Leontiev, 1978; Engeström, 1987), an activity is seen as a goal-directed interaction between a subject (the actor) and an object (the environment), mediated by tools and signs. The findings suggest that “Identify Possibilities” is a crucial part of this interaction, occurring when the flow of activity is disrupted. The actor, guided by their goals, scans the environment to identify affordances that can serve as mediating tools to continue the activity. This aligns with Activity Theory's emphasis on the dynamic, contextualised nature of human activity.

Installation Theory (Lahlou, 2017) posits that human behaviour is channelled by “installations” - the physical, social, and psychological contexts in which activities occur. "Identify Possibilities" can be seen as a process by which actors navigate these installations. When a disruption occurs, the actor must identify new possibilities for action based on the affordances provided by the current installation. This resonates with Installation Theory's idea of a "world of possibilities" - the set of actions enabled by a given installation.

NDM (Klein, 2008; Lipshitz et al., 2001) focuses on how people make decisions in real-world, complex, and dynamic environments. The findings around “Identify Possibilities” align with several key features of NDM:

1. Situation assessment: "Identify Possibilities" involves a rapid assessment of the situation following a disruption, similar to the situation assessment processes described in NDM.
2. Recognition-primed DM: The findings suggest that actors often identify possibilities based on recognized affordances in the environment, which resonates with the recognition-primed decision model (Klein, 1993).
3. Contextual factors: "Identify Possibilities" is heavily influenced by the context of the activity and the actor's goals, aligning with NDM's emphasis on the role of context in DM.

Identifying possibilities highlights the dynamic, contextual, and embodied nature of MDM in everyday activities as actors navigate disruptions by identifying actionable possibilities in their environment. These connections not only validate the findings but also demonstrate their potential to bridge and enrich existing theories of human activity and DM.

6.1.9 Create Possibilities

In our analysis of MDM processes, we've identified two key mechanisms that come into play when a disruption occurs in the flow of activity: identifying affordances and exploring possibilities.

1. Identifying Affordances (Bottom-up process): This process involves taking information from the environment, often through scanning. It's a bottom-up mechanism where the actor becomes aware of what affordances suggest as the context changes and the situation unfolds (see previous section for examples). Here, the participant is actively scanning the environment to identify affordances that might suggest a course of action.

2. Exploring Possibilities (Top-down process): This process involves extracting information from memory, often through simulation or remembrance. It's a top-down mechanism resulting from predictions stemming from previous actions and experiences. For instance:

*"I went for the smaller knife first, but it wasn't cutting well. That's why you see me pause there for a second, I'm actually thinking if and what to do. Then I remembered that this is the smaller knife doesn't cut that good. The bigger one is more sharp. And there…that's why you see me hesitating there, I decided to take the bigger one." **– P48***

In this case, the participant is exploring possibilities based on their past experiences and knowledge, rather than immediate environmental affordances.

The interaction between these two mechanisms is crucial for understanding MDM. Under normal circumstances, there's a continuous flow where incoming affordances (bottom-up) are compared to predictions based on previous actions (top-down). When there's a mismatch between these two flows - when the affordances don't align one-to-one with the predictions - a breach in the flow of activity occurs.

To restart the activity flow after a breach, the subject must feed one or both of these flows to achieve a match that will enable action to resume. This can happen in three ways:

1. Finding a matching input by exploring the environment (identifying affordances).
2. Generating a new "prediction" or simulation that matches the available affordances (exploring possibilities).
3. Changing both - potentially leading to a reorientation of the entire activity. In changing both, the actor creatively explores both internal and external spaces to create a new set of matching predictions and affordances. This is done by exploring the current environment with a larger set of search images to see if another path of action would find the proper scaffolding with relevant affordances in the environment.

   For example, realising that what he has does not have the right affordance at hand, P15 thinks creatively of a new affordance ("something sharper") that would fit the function and then explores the environment to find something that has this affordance.

   "I needed something sharper to fit in the sinkhole. I was scanning to see what I use, and the knife in the dishwasher looked like it would fit and do the job. […]

> *Yeah, I did quickly kind of glance around the kitchen, spotted a few options in the drawer, chose the most suitable one, which was the sharpest [to remove the sinkhole blockage], and used it.”* ***- P15***

This perspective aligns with both Activity Theory (Leontiev, 1978; Engeström, 1987) and Installation Theory (Lahlou, 2017). In Activity Theory, we see the actor's active role in transforming their environment through both identifying existing affordances and creating new possibilities. In Installation Theory, this process illustrates how actors navigate and potentially reshape the “installations” that channel their behaviour.

In Activity Theory (Leontiev, 1978; Engeström, 1987), the concept of "Create Possibilities" can be seen as part of the subject's (actor's) active role in transforming the object (environment) through their actions. When faced with a disruption, the actor not only identifies existing affordances but also creates new possibilities for action by drawing upon their skills, knowledge, and creativity. In P48’s case above, this involves enriching the environment within reach (the zone of action) with a “new” object, the big knife. This aligns with Activity Theory's emphasis on the generative, transformative nature of human activity.

Installation Theory (Lahlou, 2017) suggests that actors navigate "installations" - the physical, social, and psychological contexts that channel behaviour. "Create Possibilities" can be interpreted as a process by which actors actively use their embodied competencies to reshape these installations to enable new courses of action. When faced with a disruption that the current installation does not easily accommodate, the actor may need to create new possibilities by modifying the installation (e.g., introducing a new affordance in the setting as with the big knife) or their relationship to it. This highlights the dynamic, bi-directional relationship between actors and installations.

By distinguishing between identifying affordances and exploring possibilities, we gain a clearer understanding of the temporal order of operations in comparing the current situation to the goal. This framework helps explain how individuals navigate disruptions in their activities and make micro-decisions to resume their goal-directed behaviour.

NDM (Klein, 2008; Lipshitz et al., 2001) emphasises how people make decisions in real-world, complex, and dynamic environments. "Create Possibilities" can be connected to several aspects of NDM:

1. Mental simulation: NDM research has identified mental simulation as a key process in NDM (Crandall et al., 2006). "Create Possibilities" may involve a form of mental simulation, where actors imagine potential courses of action based on their knowledge and experience.
2. Creativity and improvisation: NDM also recognises the role of creativity and improvisation in real-world DM (Mendonça et al., 2004). "Create Possibilities" can be seen as a manifestation of this creative, improvisational aspect of NDM.

Dual Process Theory: Dual Process Theory (Kahneman, 2011; Evans & Stanovich, 2013) distinguishes between two types of cognitive processes: System 1 (fast, automatic, intuitive) and System 2 (slow, deliberate, analytical). "Create Possibilities" seems to involve a blend of both types of processes. The actor may draw upon their intuitive knowledge and skills (System 1) to generate potential courses of action but may also engage in more deliberate problem-solving and mental simulation (System 2) to create new possibilities.

Situated Cognition and Embodied Cognition: "Create Possibilities" also resonates with the ideas of situated cognition (Hollan et al., 2000; Hutchins, 1995; Lave, 1988; Suchman, 1987) and embodied cognition (Bassó & Herrmann-Pillath, 2024; Varela et al., 2016; Wilson, 2002). The findings suggest that actors create new possibilities not just through abstract mental processes but through their embodied interactions with the environment. This may involve physically manipulating objects, moving around the space, or using their body to simulate potential actions. This highlights the deeply situated and embodied nature of creative problem-solving in everyday activities.

In summary, the Create Possibilities component can be meaningfully connected to key ideas from Activity Theory, Installation Theory, NDM, Dual Process Theory, situated cognition, and embodied cognition. It highlights the active, generative role of actors in shaping their environment and creating new possibilities for action when faced with disruptions. These connections suggest that creating solutions and possibilities is a complex, multi-faceted process that involves a blend of intuitive and deliberate cognitive processes deeply rooted in the actor's embodied engagement with their situational context.

6.1.10 Activity Extinction

The activity extinction component of our model, which usually represents the natural conclusion or completion of an activity, aligns with research on goal attainment and the temporal dynamics of motivation. It can also happen after an Abandonment if the continuation appears too costly, difficult, or impossible.

In the first case, attaining the goal usually extinguishes the motivation for that specific activity. The "goal gradient hypothesis" (Hull, 1932) suggests that individuals become more motivated and persistent as they approach the end state of a goal. Similarly, the "U-shaped curve of motivation" (Touré-Tillery & Fishbach, 2011) proposes that motivation and effort increase at the beginning and end of a goal pursuit, with a slump in the middle.

The activity extinction component can also be understood through the lens of the "Zeigarnik effect" (Zeigarnik, 1938), which suggests that individuals have a better memory for incomplete or interrupted tasks than for completed ones. This resonates with our findings, where participants described a sense of satisfaction or closure when an activity was successfully completed or a goal was achieved. The extinction of activity can thus be seen as a natural endpoint in the goal-pursuit process, marking the transition to a new goal or activity.

The completion of the action/task is evaluated through a comparison between the action outcome and a mental representation of the desired state. Upon formulation of the goal, the actor enters a tunnel of sequenced actions and is guided by the installation towards the realisation of their mental representation of the goal. Such a process may lead the actor into a (more or less) different outcome compared to the initial simulation of the final goal. However, since the process was guided and perceived as completed when the motive is satisficed, the actor is then satisfied with the outcome, overlooking the (slight and acceptable) deviation from the initial simulated outcome. In other words, channelled by the installation, the actor compromises the desired final outcome, perceiving the activity as completed if the result is satisfactory and contributes (more or less) to the desired/required final state.

Thus, contrary to the rational choice theory (Simon, 1955, p. 99), the final judgement of the action/task outcome typically occurs using a “satisficing” (Simon, 1990, p. 9) heuristic, eventually resulting in outcomes that are experienced as “good enough” (Webley et al., 2002, p. 10), rather than emerging from a maximising mindset. This may be due to what participants explained as trying to consider some type of efficiency for action control, ultimately leading them into “streamlining” (P1) their activities and/or tasks. Best outcomes are thus compromised with good enough ones by the actor to save time (increase speed) and/or physical and mental energy (cognitive capacity). Additionally, this line of findings sits well with certain research trends in evolutionary psychology, which consider “time and energy as two of the most important factors in cost-benefit analyses of the evolution of animal behaviour" (Todd, 2001, pp. 53–54). In the same spirit, humans acting as cognitive misers has been an old theme in cognitive and social psychology (Evans & Stanovich, 2013), leading them to substitute an easy-to-evaluate characteristic for a harder one, even if the easier one is less accurate (Kahneman & Frederick, 2002).

An interesting aspect of our empirical data is that the activity extinction is not considered as a "decision" by our participants. This makes sense in the framework of our prediction-error model since decisions are only necessary when there is a discrepancy between expectations and experience. As reaching the goal is precisely meeting expectations, there is no prediction error then, and hence, no MDM is necessary.

While the activity components above are inferred from our observations, some aspects of the process appear as behaviours; they are the operational movements that enable the components above. These are Pause, Hesitation, scan, and retry. While these other components may not differ ontologically from the above, they are special in that they are more easily observable and quantifiable because of their objective manifestation as behaviours. In a full-fledged theory, the distinction between the activity components and these behaviours that are also activity components may have to be reassessed, but at this stage, and as a precaution principle, because they were in this research used as observables, we describe them in a distinct section.

6.2 BEHAVIOURAL ASPECTS

We observed these activity components in our data through some behavioural variables that we identified throughout our exploratory and pilot studies and tested and refined through RIWs and RRIWs. behaviours. The variables identified in our analysis—pausing, hesitating, scanning, retrying, and giving up—offer a window into the cognitive processes underlying MDM.

What we observed is that activity is a process of continuous orientation of how we chain successive actions, sometimes seamless (fluid flow), sometimes following a breach in the flow that leads to the activity becoming disrupted. These moments following a disruption of the activity, or the extinction of a previous activity are precisely what were identified as MDM according to the subjective experience of our participants. We operationally observed these breaches through participants pausing, hesitating, and scanning to (re)reorient when encountering a situation that was unexpected to them or just deciding to abandon the goal pursuit and activity.

These behaviours attempt to couple the participant with their environment. They are behaviours through which the activity components described above are performed in an operational way, and we observe them in our footage. For example, we observe the participant identifying affordances by looking around and moving their head to scan the environment. Our research identifies them as manifestations of cognitive control processes engaged during the breached activity paths; some of these lead to processes experienced as MDM.

These behaviours align with theories of cognitive control and executive function (Botvinick et al., 2004; Diamond, 2013), which emphasise the role of higher-order cognitive processes, such as attention, working memory, and inhibitory control, in guiding goal-directed behaviour and adapting to novel or challenging situations.

6.2.1 Pause

Pauses mark an interruption in the automatic flow of activity, where the individual may be weighing options, considering the consequences of different actions, or simply taking a moment to gather thoughts. The frequency of pauses underscores the cognitive effort involved when the fluidity of activity is breached, and participants need to reorient themselves, which in turn leads to subjective experiences of MDM. The fact that a pause is not simply a stop in the sequence, followed immediately by another sequence, but takes time shows that the process of orientation takes a toll on the action. The average duration of pause is approximately 4.37 seconds, and the standard deviation of the duration of pause is approximately 3.44 seconds. The least duration of a pause was recorded as 2 seconds, and the longest duration of pause recorded in our datasheet was 30 seconds, which belonged to the Social Media activity category. Figure 33 (below) shows the distribution of the average duration of pauses across activities. The total pause duration was computed by summing up the duration of each pause that we recorded when coding the data. We normalised the average pause duration by dividing the total pause duration by the total duration for each activity. This provided a ratio that reflects the proportion of time spent pausing relative to the total time spent on the activity rather than just the raw pause durations. The bar chart displays the normalised average pause duration for each activity, sorted from the highest to the lowest. In Figure 34, each bar represents the normalised average pause duration, expressed as a proportion of the total activity duration. This normalisation allows us to compare activities fairly, regardless of the total time spent on each.

Figure 33

Average Duration of Pause Distributed among Activities

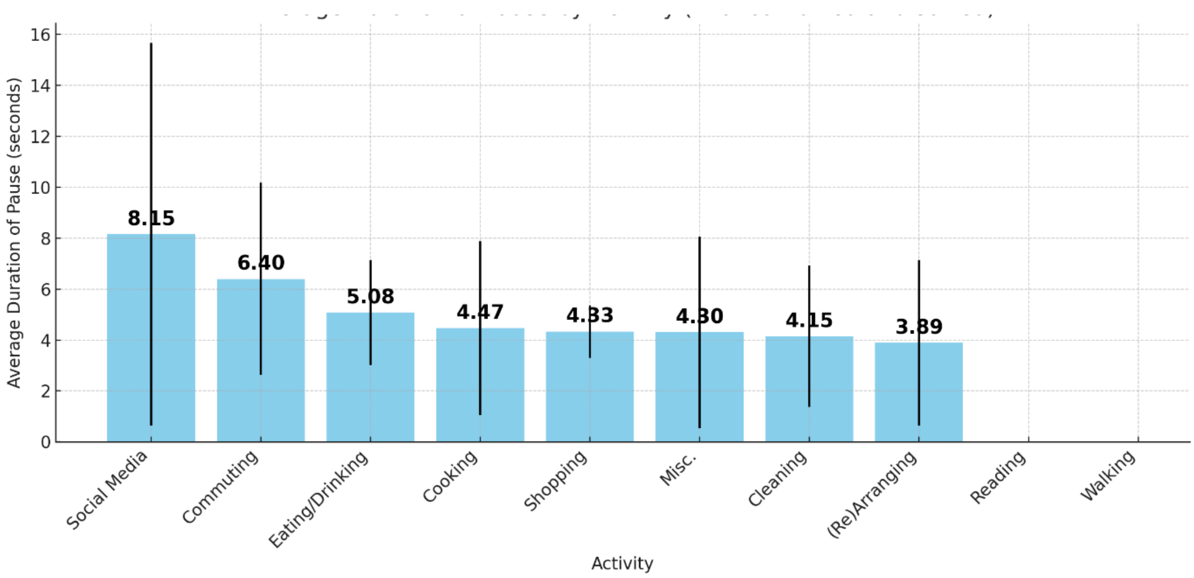
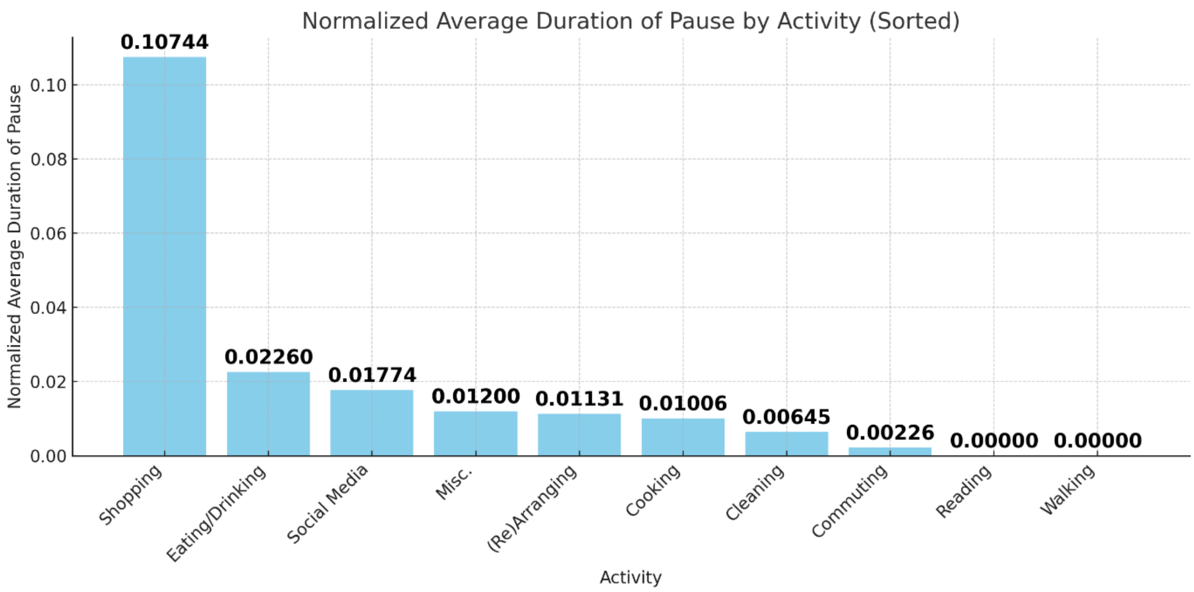


Figure 34

Normalised Average Duration of Pause Distributed among Activities



As long as a new path of action has not been chosen, it is understandable that the subject does not act, but deciding what action to take is a process *per se*, a process that takes time and effort. This MDM cost should be considered in parallel with our interpretation of "giving up." When this cost is considered too high, the decision can be avoided altogether.

In the literature, pausing has been associated with various cognitive processes, such as information processing, DM, and response selection (Baddeley, 2012; Diamond, 2013). For example, research on speech production has shown that pauses can reflect the cognitive demands of planning and formulating utterances (Garman, 1990). Similarly, studies on problem-solving have found that pauses can indicate moments of impasse or restructuring, where individuals are actively searching for new solutions or strategies (Fleck & Weisberg, 2013). Our findings are consistent with this literature.

6.2.2 Hesitation

Hesitation is closely related to pause but carries an additional element of uncertainty or ambivalence. Hesitation often manifests in situations where the decision is not straightforward (yes/no), indicating a conflict between competing options (we see this via a rapid shift in focus and attention between two or more objects) or uncertainty about the optimal course of action. The observed hesitations highlight the complexity of even seemingly simple decisions, reflecting the cognitive processes of evaluation and deliberation that characterise human MDM in situations where reorientation is required.

> *"I was about to add salt [to the dish], but then I hesitated, yeah. You can see me holding the thing [salt shaker], and then putting it down, then picking it up again [laughs]. I was trying to remember if I had already added salt earlier or not, hence the confusion, and this is, like, really embarrassing [both laugh]. Well, to be fair, I didn't want to over-salt the food, but I also didn't want it to be bland. It took me a moment to decide. I think I eventually added just a small bit to be safe."* – ***P27***

This example showcases hesitation due to uncertainty about a previous action and the potential consequences of the decision.

> *"This is actually, so, like, part of the cleaning process. I saw the pile of papers on the surface there, and I'm also kind of scanning a bit to see what they are and which ones I need to keep, or maybe they're my husband's. I hesitated over this one because I wasn't sure whether to throw it away or keep it. Part of me thought I might need it later, but I also really want to clean and [declutter]. I'm finally deciding to keep it, I think…yeah."* – ***P42***

Here, the hesitation stems from the conflict between two competing options, each with its own potential benefits and drawbacks.

So, hesitation is a behaviour that signals conflict between options. It underscores the deliberative processes involved in human DM, even in routine tasks, in which the course of action is not quite so "obvious" as it is no longer fluid and motivated by the environment and installations. Table 6 on page 125 in Activity components and MDM shows the distribution of hesitation across activities.

Hesitation has been studied in various contexts, such as consumer DM (e.g., Cho et al., 2006), moral judgments (e.g., Szekely & Miu, 2015), and response inhibition (Bari & Robbins, 2013). These studies suggest that hesitation can reflect the operation of cognitive control processes, particularly in situations that involve conflicting information, competing goals, or the need to suppress prepotent responses. For example, research on response inhibition has shown that hesitation can be an indicator of the engagement of inhibitory control mechanisms, which are necessary for overriding automatic or habitual responses in favour of more context-appropriate actions (Bari & Robbins, 2013). Here again, our findings are coherent with the literature.

6.2.3 Scan

Scanning behaviour, which involves looking around to evaluate the environment or gather information, is indicative of an active search process. This behavioural variable is crucial for situational awareness (Endsley & Garland, 2000) and plays a key role in identifying affordances, options, and opportunities within the environment. Scanning can be seen as a preparatory action for MDM, enabling individuals to make informed choices based on the current state of their surroundings. Table 6 (see Activity and MDM) summarises our findings of the number of scans we observed distributed across everyday activities in our data.

The importance of scanning and information search in DM has been highlighted by various theories and models, such as the adaptive decision-maker framework (Payne et al., 1993) and the ecological rationality perspective (Todd & Gigerenzer, 2012). These approaches emphasize that decision-makers actively seek out and use information from their environment to guide their choices rather than relying solely on internal knowledge or predefined strategies. Scanning has also been studied in the context of visual attention and perception, where it is thought to reflect the allocation of attentional resources to relevant stimuli in the environment (Carrasco, 2011; Wolfe & Horowitz, 2017). Lahlou (2006) notes that subjects can use scanning to look for objects in their environment (in that case a secretary looking on her table for a pen to take some notes) rather than searching their memory to find where they put it, as if sensory exploration was a more efficient, or perhaps faster, heuristic. “she scans the space with her gaze, turning her head left and right. So it is primarily the spatial environment that she explores, to confront it with a search image, rather than her own memory, contrary to what many theories suggest”(Lahlou, 2006, our translation).

More generally, Lahlou (2008, p. 102-108), using Subcam data, notes that subjects *continuously* scan their environment to couple their current action with affordances. “Through this sensory exploration, the subject instantiates "objects" in his mind, without necessarily having a preconceived idea of what he is trying to perceive. Scanning can also be guided by a "search image": the subject searches the context for an object of a particular type (Lahlou, 2008, p. 103). The recognition of objects triggers representations, which in turn suggest actions, as most representations are prescriptive. The perception-action loop is mediated by representations, which link objects to actions.

Lahlou considers the mental representation as the structure that enables the operational coupling, in situation, between the current context and the action: “There is only one single operational mapping movement, which supports both the reconstitution of the relevant representation from objective elements of the context and the execution of the relevant action of the representation onto the objective elements of the context.” (Lahlou, 2008, p. 108, our translation). In this process, the subject scans the environment with the search image for an affordance that fits the desired action (e.g., looking for the telephone to give a call) and finds it: that is the successful coupling with the environment. The search image results from the articulation of a representation that associates giving a phone call (the goal) with the image of a telephone (the affordance).

What we coded here as “scan” is not this continuous, successful scanning of the environment during action but rather those scanning movements that take place during pauses of action at the breach of flow. In these moments, scanning is not the continuous exploration that maps the feed-forward anticipation of the subject to the context described by Lahlou but precisely an effort to find some new affordance because, indeed, the continuous process of coupling has failed. These cans are an effort to reboot a coupling; therefore, they are likely to be more open and wide than the continuous control scan that takes place during the flow, is oriented by a search image, and was precisely faulted previously.

Here again, our data confirms this literature with more empirical data.

6.2.4 Retry

The act of retrying is an attempt to overcome a minor obstacle or initial barrier within the activity flow before it is perceived as a problem or failure. This behaviour points to resilience and persistence in the face of challenges, and it also suggests an initial preference for sticking to planned actions or routines before considering alternative strategies.

The relationship between retrying and MDM appears to be rather simple. While retrying may not directly lead to a micro-decision, it can trigger, if unsuccessful, a reassessment of the situation, thereby influencing the MDM process. In other words, we found that retrying is essentially a heuristic process through which participants attempt to avoid a cognitively expensive breach in the fluid flow of activity. In the cases we observe, this rather appears as some automatic, thoughtless attempt to get a satisficing result by trying again the same movement, which is likely more economical than pausing and reassessing the situation. So, that is a very different thing than grit and resilience, and it would rather be compared to rigidity.

Retry, or perseverance, has been investigated in various domains, such as problem-solving (Fedor et al., 2015), learning (Di Domenico & Ryan, 2017), and goal pursuit (Ntoumanis et al., 2014). These studies highlight the adaptive value of persistence in the face of challenges and setbacks, as it can lead to improved performance and goal attainment. However, research has also shown that excessive persistence can be detrimental, particularly when it leads to perseveration or the continued use of ineffective strategies (Bari & Robbins, 2013). In the context of our model, retry seems to represent a balanced form of persistence, where individuals make initial attempts to overcome obstacles before engaging in more effortful MDM processes.

In the line of Gigerenzer's ecological explanation for the efficacy of heuristics (these shortcuts were adopted because they were efficient in practice, not because they are logically good but because of the properties of the environment), we could hypothesise that retry may actually work for empirical reasons. The first can be that the movement was not properly executed the first time (e.g., the key was not properly inserted in the lock). Or because the affordances were not properly assessed (e.g., the push was not strong enough). Or because the attempts actually have an impact on the affordance (e.g., if the beggar insists the person might yield if the first blow of the axe did not cut the tree, a series of blows will). As mentioned already in the section on Retry in our Research Findings chapter, this strategy of retrying is successful 70% of the time, which accounts for the fact that subjects make several retry attempts (on average, 3, as described previously). So, retry is a good heuristic.

6.2.5 Give up (Abandonment vs. Avoidance)

We found two distinct types of giving-up behaviour in our data. The first represents abandoning a particular course of action, often in response to insurmountable obstacles or a reassessment of the situation's demands relative to the individual's goals or resources. This variable highlights the adaptive nature of human MDM, where discontinuing an action is a viable option in the face of diminishing returns or excessive costs. This abandonment led to the experience of making a micro-decision.

The other type was simply avoiding MDM altogether due to a lack of resources or motivation. This MDM avoidance was not accompanied by MDM experiences: the participants explained "not wanting to deal with" and having to decide how to reorient. In those circumstances, it seems that the subject simply moves on with the activity, accepting the situation, as if the prediction-error did not matter enough to trigger a costly reorientation process. We call this process "avoidance".

The concept of giving up or disengagement has been studied in various contexts, such as problem-solving (Payne & Duggan, 2011), self-regulation (Scheier et al., 2001), and goal adjustment (Wrosch et al., 2003). These studies suggest that the ability to disengage from unattainable goals or ineffective strategies is an important aspect of adaptive self-regulation and can contribute to well-being and resilience. However, premature disengagement can also be problematic, as it may lead to missed opportunities or the failure to develop necessary skills and strategies (Dweck, 2006).

In the context of our model, abandonment seems to represent a strategic form of disengagement, where individuals abandon the task after consideration of the costs and benefits involved. This results in abandoning the task, which is a micro-decision.

But the other aspect of giving up, the avoidance of MDM, is more novel in the literature. This interesting aspect, which is documented here for the first time on such data, at least at this scale of hundreds of occurrences, is where the MDM process appears as an action in itself, an action that has a substantial cost. That is visible in the fact that the MDM is avoided as the subject "gives up" because the MDM would require "too much cognitive effort" or because of missing data. This aligns with the notion of "strategic allocation of cognitive resources" (Wrosch et al., 2003), which suggests that individuals actively regulate their cognitive efforts based on the expected value and costs of engaging in a particular task or decision. This avoidance of the MDM also visible in the fact that MDM is avoided when the subject retries instead of trying to reflect and understand why the action failed.

This comforts the description of humans as “cognitive misers”, and in this, our findings are consistent with the literature. It also highlights the fact that conscious DM is a *process* that takes time, requires a halt in action (see how the processes usually involve pause, hesitation and scan, which are immobilising and time-consuming) and the focus of conscience on reasoning and internal simulation of potential activity paths, which is energy consuming.

6.3 GENERAL DISCUSSION OF THE EMPIRICAL FINDINGS

The empirical findings highlight the significant role of the physical environment and the actor's psychological state in shaping MDM. The social setting is also important, but we have less data in our empirical material where participants mostly recorded activity that was individual. Nevertheless, in the few cases where the subject was not alone, this influence was very clear. Other participants are a source of information, influence, affordances and feedforward, as we saw, e.g., with a participant using her mother’s recipes or another asking her roommate for advice on how to fix a problem with an appliance.

In an attempt to capture some data on interactions and groups, we asked P17 and P25 to wear the subcam simultaneously as they went about their daily activities. Below are some examples we obtained from our RIWs and RRIWs, although further data collection on activities with multiple actors is required to analyse this in detail. What we provide below as examples are the RIWs from P17 and P25 on the same instance and as they were cleaning their house. Thus, we see two different perspectives (one from P17 and the other from P25) on the same situation.

> ***Interviewer:*** *Can you tell me what’s going on here?*
>
> ***Participant 17:*** *Sure, my wife and I are about to clean the house.*
>
> ***Interviewer:*** *You seem to be waiting a lot, or is there something else going on maybe?*
>
> ***Participant 17:*** *Well, you could say I’m waiting for some orders! [laughs] […] We divide the responsibilities to some extent. Both to save time and because we always divide the housework. So, I’m waiting here for my wife [P25] to plan how we are*

going to do [clean] the living room. She is obviously more experienced and skilled in these tasks, so throughout the entire activity, I think she makes the more strategic decisions; while I basically try to finish my tasks and make sure I accomplish them well, I mean I better! [laughs] […] I do make decisions, albeit small ones, but perhaps on events such as whether I should wipe that are twice, or perhaps I should take care of the dishes while she is hoovering. That sort of decision. I believe it is a combination of practising agency, as well as trusting [wife] with making the majority of the decisions and task allocation. […] As you can see, I keep reporting back to her like a good cadet once I'm done, and she either tells me to wait or gives me more tasks to finish whilst she is busy with other objectives.

We then asked about the same situation from P25, who was cleaning alongside P17:

Interviewer: *Can you walk me through what's happening in this clip?*

Participant 25: *My husband and I are about to start our weekly house cleaning routine. You can see me pausing here as I enter the living room; it's not a pause; I'm scanning the living room just to see what state it is in. My husband [P17] usually won't notice how often the house needs cleaning, so it's mostly my way of managing the house and, in light of your research, my decision. The living room is not very bad, but I decided to do a quick round of cleaning. Hoovering is always necessary because we get a lot of hair on the floor. Mopping is just what comes after hoovering for me, naturally. […] I do the hoovering myself and ask my husband to do the mopping. Mopping needs more force, and you need to press the mop to the floor to make sure it's actually cleaning the floors, so I ask him to do this. […] I ask him to bring me some stuff, wipe here and there, or check something for me every now and then. You could say that I am managing the process, but he also does some tasks and helps with the cleaning process. I also sometimes monitor and ask him to redo [it]. There the stain on the sofa is still there, so I asked him to wipe the sofa again, but this time with a bit of soap because soap always cleans the sofa without damaging it. He wouldn't know this information, so I have to make sure to mention it.*

This dialogue illustrates several key aspects of our research:

- The behavioural variables (scan, hesitation, pause)
- The process of identifying and creating possibilities
- The role of affordances in the environment
- The social dimension of MDM
- The occurrence of disruptions and how they're resolved
- The fluid nature of the MDM process in everyday activities

It also demonstrates how participants can become aware of these processes when prompted to reflect on their actions, providing valuable insights into the subjective experience of MDM.

The decision ecology within which these micro-decisions are made influences not only the frequency of DM moments but also the nature of the decisions themselves, as we saw with the rather different structure of breaches in the flow and MDM in different activities. This confirms the obvious: that MDM is not merely a function of internal cognitive processes but is deeply intertwined with external contextual factors. Therefore, again, we should remain careful when making generic assumptions from observations on one single type of activity.

These empirical findings, while they contribute to a deeper understanding of everyday MDM, challenge simplistic models of human behaviour that do not account enough for the complexity of MDM, and especially their situated and dynamic character. The identified behaviours and their context-dependent nature suggest that everyday tasks are, rather than passive execution of routine actions, subject to continuous oversight and control. We put forward the hypothesis that such activities, which are goal-directed, are fed-forward by the installations (built and societal environment combined with the participant's previous skills and experience) but also monitored by a prediction-error control system that flags discrepancies in the flow as compared to expectations, and then halts the current process to trigger reorientation and MDM.

As long as the installation channels a fluid and satisficing activity, there are no breaches and the actions chain together smoothly and lead to the goal. But if there is some motor blockage, or if the experience is too far from expectations (according to internal monitoring), the activity comes to a halt, and an MDM may occur.

As we saw, this MDM occurrence is not systematic. If a retry solves the block, there is hardly any MDM. And in many cases, as for shift, the flow can continue without serious breach.

The image of MDM we get from this analysis of mundane, ordinary activities is a rather low level of complexity. Many of these MDMs are psychophysical (affordance evaluation), and others are simply comparing various motor paths for efficiency. In a way, most animals can do this.

One of the most striking findings is the frequency of breaks in the flow of activity, which occur on average every 1 minute and 5 seconds, with a micro-decision being made approximately every 1 minute and 26 seconds. This high frequency underscores the constant negotiation and DM individuals engage in as they perform everyday tasks, even if those MDM are of rather low level of complexity and can be solved with simple exploration of the environment for resources or pathways.

This also reminds us that a lot of our lives are about motor action to get where we want or change the situations to what we want by simply navigating or manipulating the state of our physical or social environment.

Complex tasks like cooking or cleaning finally appear to be decomposed into a series of small, low-level tasks, as we saw in the example of the recipe. The process is not a complex decision with a high-level comparison of the utility of various recipes but rather a path of constructing the solution step by step with simple choices, opportunistically exploiting the affordances in the environment and filtering them with one's skills and expectations. The high number of breaks is a testimony to this gradual construction, made of frequent small adjustments to the conditions encountered.

The fact that a significant majority of these breaks (around 84%) were classified as micro-decisions highlights the pervasiveness of MDM as a conscious operation in daily activities, challenging the notion that everyday tasks are performed in a purely automatic or mindless manner. In other words, while the picture we get from these data fits well with what Installation theory describes as channelled states, these channelled states are not purely automatic and unconscious. A better metaphor would perhaps be a plane that is on autopilot, but where there are pilots in the cockpit overseeing the journey, making sure everything goes as expected, and taking over when there is some discrepancy.

While these findings seem to resonate with broader research on human DM, which suggests that individuals make thousands of decisions daily, they also imply that a considerable proportion of everyday activities occur without subjective experiences of MDM. One widely-cited study by Sahakian & Labuzetta (2013) suggests that adults make about 35,000 remotely conscious decisions each day. This estimate is based on the idea that individuals make approximately one decision every two seconds, which equates to over 220 decisions per waking minute. However, it is important to note that this estimate includes both conscious and unconscious decisions, and the methodology behind this calculation is not entirely clear. Another study by Wansink & Sobal (2007) focused specifically on food-related decisions and found that people make an average of 226.7 decisions about food each day. It used a combination of 24-hour food recalls and interviews to assess the frequency and nature of these decisions in a sample of 139 adults.

While these studies provide some insight into the potential frequency of DM in daily life, it is important to interpret these estimates with caution. The exact number of decisions made per day is likely to vary widely depending on individual differences, situational factors, and the specific criteria used to define a “decision”. In the context of this research, the finding that a micro-decision was made every 1 minute and 26 seconds on average during mundane everyday activities suggests a relatively high frequency of MDM, even if the exact number of decisions per day is not directly comparable to the estimates from previous studies. The novelty of our study first lies in the fact that this estimation of what is MDM is provided *by the participants themselves*, grounded in the evidence of their re-enactment of the situation as they watch their subfilms.

In sum, our research provides a more nuanced understanding of MDM: not every microscopic action requires a conscious decision; on the other hand, purely automatic behaviour seems to be limited to small sequences (what activity theory calls “operations”) and the transition from one operation to the next appears under some control process, which we hypothesised is a prediction-error mechanism. There appears to be awareness without intense attention unless something goes wrong or unexpected. This light touch control seems akin to peripheral attention, a cognitive mechanism that runs in parallel, a mechanism that wakes up when a problem occurs, and higher and more expansive processes that otherwise remain in standby mode.

What differs from the dichotomic approach of Systems 1 and 2, and more generally from the notion of consciousness as a crisp awareness of all elements of a situation, is this intermediate state of “background” awareness of the situation as it unfolds, that seems to mobilise minimal cognitive resources unless some errors (as compared to what the subject expects) arise, which then trigger a richer awareness and reassessment of the situation -unless some mechanical “retry” fixed the problem. But that richer reorientation process is also costly in time and cognitive resources, and the mechanisms of retry and avoidance show that subjects will try to spare it if possible.

A good example of this process, which most people have experienced, is navigating the usual home-to-work journey. When everything is normal, this journey is made in semi-automatic mode, with just a little background attention, the junctions following on naturally as you progress. But if a road is blocked, for example, for roadworks, the route is consciously and deliberately re-evaluated in a reorientation process with a decision requiring more sustained attention and exploration of the environment.

Another novelty lies in our focus on the moment-to-moment dynamics and contextual factors that shape MDM in naturalistic settings rather than on providing a definition and estimate of the total number of decisions made per day. Indeed, we intentionally refrained from providing *objective* definitions for a "decision". Our novel methodology enables us to access the subjective experience of what was *experienced* as making a micro-decision by our participants.

We also described operationally what breaks in the flow of activity and analysed what appears as (re)orientations. As appears from our work, the relevant notion would rather be the orientation process than "decision-making". Indeed, if at these orientation points, the orientation taken coincides with what are the expectations of action (e.g., turning right as usual at the intersection when going to work), this is not *experienced* as a decision. But if, at the same intersection, the road is blocked, then not turning right will be *experienced* as a decision. Therefore, the very notion of decision is contextual and does not only depend on the behaviour (turning or not) but on whether this behaviour corresponds, or not, to a fed-forward "next expected step" in the channelled state. That is obvious in the many occurrences of our participants who explain that *this time*, this specific action is not a decision, but it was the first time (long ago) when it was performed.

> *"I've poured oil into pans enough times in the past to know how much oil I need to the meatball, so I just eyeball it [how much oil to pour in the pan]."* ***– P23***
>
> *"I think the first time I developed this particular way I arrange the dishes [in the dishrack], I definitely decided how to do it, like, I always put the cups first so that I can the sort of, lean the dishes to the cups and that way they will dry more easily. But I don't think I decide for this anymore. I've been doing it for ages. Yeah…no."* ***– P60***

***

> ***Interviewer:*** *I noticed you paused briefly at this intersection. Can you tell me what was going through your mind?*
>
> ***Participant 42:*** *Ah, yes. That day was different. There was construction work, and the right turn was blocked. You can see me scanning the area, trying to figure out what to do. That felt like a real decision moment. I had to consciously think about whether to take a detour or find another route entirely.*
>
> ***Interviewer:*** *And how does this compare to when you first started this commute?*
>
> ***Participant 42:*** *That's an interesting point. When I first started this job, every turn was definitely a decision. I mean, I even used Google Maps and Waze as well just to make sure that I don't end up lost. I remember deliberately choosing to turn right at this intersection because it seemed like the most efficient route. But like, over*

time, it became automatic. I definitely don't decide anymore unless I have to like, change this particular route for some reason, but otherwise, I don't think I even notice anything in my surroundings which is definitely not good for my mental health, but I'm already thinking about other things, like my work and stuff as soon as I'm on the road.

This illustrates the difficulty of qualifying an orientation as a decision or not based on behavioural criteria only since the same observable motor behaviour can sometimes be a decision and sometimes not, depending on whether the subject is in channelled mode or not.

Furthermore, it is likely that the background attention mode corresponding to the channelled state has various degrees of arousal, so the switch from autopilot to full-fledged reflexive consciousness may not be as abrupt as a transition for a purely automatic system 1 to a highly reflexive system 2. The level of the threshold that triggers a prediction error detection may also vary according to how critical the task is (e.g., in driving fast versus hoovering) and how skilled the subject is.

Furthermore, the exact number of "decisions" is challenging to quantify due to the vast range of decision types (from trivial to significant) and the variability in individuals' daily activities. Depending on these, some orientations are made almost automatically or habitually with little conscious thought, while others require deliberate and extensive cognitive effort. The context, complexity of the task at hand, individual differences, and even cultural factors can significantly influence the number of "decisions" experienced. While the previously mentioned numbers of decisions in the literature encompass a wide range of decisions, from the trivial to the significant, our study specifically focuses on micro-decisions within the context of daily tasks, offering a detailed view of the DM process at a granular level, but for these types of tasks only. A count of decisions in different settings, such as the artificial problems proposed to participants in lab experiments, would likely be very different.

Research in DM psychology and behavioural sciences often focuses more on understanding the processes, biases, and effects of different types of decisions rather than quantifying their daily frequency. This might have been due to empirical issues of introspection or having to rely on self-reported data and participants' memory, which we know is unreliable. For instance, studies may explore how people make choices under uncertainty, the impact of cognitive biases on decision quality (Acciarini et al., 2021; Phillips-Wren & Adya, 2020), or how decision fatigue affects the ability to make decisions over time (Phillips-Wren & Adya, 2020; Pignatiello et al., 2020).

A key takeaway of this research is that contrary to what has been widely circulated by popular science, our findings indicate that the frequency of "decisions", at least from a subjective viewpoint, is less than previously estimated. A lot of what seems to have been considered by DM science as decisions because they coincide with a choice between several possible paths are simply experienced as taking the next step without making a decision. To take a metaphor, an external observer describing Mrs Brown driving back home from her office might describe this behavioural trajectory with hundreds of decisions (changing gear, braking, accelerating, turning left, right, etc.) while Mrs Brown may only experience as decisions a few significant events, e.g., passing a truck in a narrow street.

This further indicates that as human beings, we engage in a significant proportion of our everyday activities is massively regulated and framed by the *context* of the decision. These decision contexts can be categorised into three layers of physical, psychological, and social as illustrated by Installation Theory (Lahlou, 2018a). Such dynamic regulation determines what activity can actually and really occur, guiding and channelling the activity process towards the actor's chosen future state. Strong regulation of behaviour through installations leaves the actor with limited (sometimes only one) possibilities for action, reducing the explicitness of subjective experiences of DM over choosing an activity, which can potentially lead the actor into meeting the chosen desired state.

Consistently, and as illustrated in the previous section, participants in such installations reported no explicit experiences of DM, perceiving the channelled activity process as *"obvious"* (P14, P8, P1, P8, P10), through which they simply have to *"go with the flow"* (P5) of a sequence of emerging actions/tasks. To sum up, the frequency of micro-decisions is lower than what is popularly perceived.

Our findings underscore the significant role of the physical environment, the actor's psychological state, and the social setting in shaping MDM processes. This resonates with neuroscience research, which suggests that DM is not solely a cognitive process but is heavily influenced by external stimuli and internal states (Kable & Glimcher, 2009; Lighthall, 2020). The concept of the decision ecology, where decisions are influenced by an individual's surroundings and mental condition, aligns with neural studies showing that the brain integrates information from a variety of sources when making decisions (Monosov & Rushworth, 2022; Rushworth et al., 2012).

The detailed observation of our behavioural variables provides a framework for understanding how micro-decisions manifest in everyday activities. These observable variables not only indicate the presence of DM moments but also suggest a level of cognitive engagement and evaluation that goes beyond automatic or habitual responses. This finding challenges the notion that daily routines are carried out in a predominantly mindless and automatic fashion and underscores the cognitive effort involved in navigating the seemingly mundane aspects of daily life. On the other hand, they also suggest that the types of decisions that are taken are not of the deliberative type that is described or tested in most DM literature. Rather, they are low-level tasks of comparing a set of affordances with a pragmatic subgoal (such as where to find a power switch or how to best fit a plate in a dishwasher) or the best relevance among a set of possible paths to get satisfaction (e.g., choosing a snack) when a participant feels hungry and wants a snack.

Take the snack example: They open the cupboard and see several options: chips, cookies, nuts, and fruit. They quickly assess each option based on their current craving (something sweet), their health goals (trying to eat healthier), and the convenience of each option (fruit requires washing, nuts are easy to grab). They decide that the nuts offer the best balance of satisfying their hunger, aligning with their health goals, and being convenient, so they choose the nuts as their snack.), or an evaluation of the cost (in effort and time) to perform a necessary step (such as going to buy the missing product to achieve the task) and compare it to the acceptable cost.

A significant proportion of such orientations and MDM are highly regulated and shaped by the decision ecology (the “installations”). Indeed, our findings highlight the significant role of the physical environment, psychological state, and social context in shaping the frequency and nature of MDM. This contextual influence suggests that the number of decisions made daily is not fixed but varies significantly depending on the individual's environment and activities. This is obvious: the more one performs habitual activities in a familiar and well-designed setting (e.g., making breakfast), the fewer decisions. This variability contrasts with the more generalised claims about DM frequency found in broader research, emphasising the importance of considering context when evaluating human DM processes. In retrospect, our choice of cleaning as an activity is especially illuminating because, precisely, it consists of “repairing” an installation and putting it back in its optimal operation mode. It is amazing that even this repair/maintenance task, which should be especially rich in micro-decisions, is itself routinised to the point that it is mostly performed in a channelled state.

Comparing our findings with the broader claims about daily DM underscores the complexity and variability of human behaviour and its distributed determinants. The frequent occurrence of micro-decisions in everyday tasks suggests that even routine activities require a substantial amount of cognitive processing and DM, but these are micro-decisions. This insight has important implications for fields ranging from cognitive psychology to behavioural economics, as it challenges researchers and practitioners to consider the continuous and context-dependent nature of DM in their models and applications.

6.4 THE PREDICTION-ERROR MONITORING HYPOTHESIS

This study's observations suggest that the basic process of MDM is a low-level feed-forward exploration of the environment, grounded in previous experience and scaffolded by the affordances in the environment that are both sought for and found. The found affordance triggers action, which leads to the next step, and this cycle continues until the goal is reached.

How does this happen unless the flow is breached, which then requires a reorientation? We propose the hypothesis of prediction-error monitoring here.

We hypothesise the existence of some prediction-error checking, a mechanism that would continuously oversight the channelled, semi-automatic process of matching the fed-forward expectations to the environment perceived as the situation unfolds. Such a mechanism does not require much deliberation beyond mere comparison of simulation (expected situation) to perception (of actual situation). It would simply flag discrepancies.

As long as the flow continues seamlessly, the mechanisms of inattentional blindness and priming contribute to focusing attention on the current course of action by barring the interpretation of "irrelevant" affordances and lowering the threshold of interpretation of “relevant" affordances” (search image).

However, sometimes, this low-level fed-forward expectations process does not produce satisficing results when confronted with the emergent situation. What happens is not what was expected. This can be due to various reasons such as lack of affordance, faulty affordance, lack of competence, social prompt, or the presence of an affordance for a stronger motive that is spotted by peripheral attention and put at the forefront of awareness. Such discrepancies between expectations and reality can be detected by the very same mechanism of comparison that sustains the feed-forward of anticipations in their coupling with the environment (e.g., a matching test). Below a certain threshold of difference, this difference is neglected, and the feed-forward continues: the context is supportive and scaffolds the actions. Above that threshold, the context is not supportive of continuation; the feed-forward is halted.

These instances lead to a breach in the flow of activity, and depending on the type of breach, different types of MDM can be observed through various behavioural cues (pause, hesitation, etc.) and the order in which they occur. Our analyses reveal the disruptions in activity flow that prompt reorientation and, potentially, micro-decisions. This finding is mirrored in neuroscience research that demonstrates how unexpected events or stimuli can trigger neural processes associated with attention redirection and DM (Corbetta et al., 2008). These disruptions necessitate reassessing the current state and formulating a new course of action, a process supported by neural mechanisms underlying cognitive flexibility and problem-solving.

Therefore, the "channelled state", which is the default operating mode in mundane situations, appears as a conjunction of feed-forward, inattentional blindness, priming by the motive, and orientation towards the goal. Installations keep the subject in a channelled state by providing scaffolding and avoiding breaches in the flow. Reorientations, including decisions, are experienced when the subject consciously attempts to address a breach in the flow and to reinstate a productive coupling with the environment, one that progresses towards the goal.

This suggests that MDM does not conform to distinct cognitive processing systems as proposed by dual-process theories (Evans & Stanovich, 2013) but rather involves a complex and more continuous interplay of perceptual, cognitive, and embodied processes, of which "system 1" and "system 2" describe extreme states.

The behavioural variables identified as indicative of MDM—such as pausing and scanning—suggest that individuals are continuously gathering and processing information from their environment to inform their decisions. These can be seen as interactions with affordances and signifiers in the environment. For example, pausing may occur when the individual encounters a new or unexpected signifier that requires interpretation before action can continue. Neuroscience research has identified similar patterns of behaviour and neural activation when individuals are faced with DM tasks, highlighting the role of the prefrontal cortex in evaluating options and making judgments (Heekeren et al., 2008). The alignment between the observed behavioural variables in this study and the neural correlates of DM identified in the neuroscience literature underscores the validity of using such markers to understand MDM.

While these observations offer a compelling perspective on the nature of MDM, it is important to note that the data presented in the study do not provide definitive support for the hypothesis of a monitoring mechanism based on prediction-error detection. Further targeted investigations, and likely more neuroscientific exploration, would be necessary to substantiate these claims and elucidate the precise mechanisms underlying the observed patterns of MDM in everyday activities. But these are beyond the scope of this thesis. What seems to be an important factor to study is the level of acceptable prediction error, in other words, the amount of acceptable difference between what is expected between expectation and perception (at the micro-level, e.g., is this surface “clean enough”). Depending on whether the difference is below or above some threshold, the action will continue, halt, or take another direction.

It is nevertheless interesting to compare the decision mechanism, in the light of our hypothesis of prediction-error thresholds, with the more general issue of satisfaction, which is, as Lahlou notes, the difference between expectation and experience (Lahlou, 2024, p.24). This suggests a very general process of prediction error checking may be acting at various levels of behavioural orientation, from micro to macro, of generating expectations and then comparing them to experience in order to act and also to learn.

In sum, our findings suggest that micro-decisions occur when the activity flow is breached, and the micro-decision is the outcome of reorientation and choosing among alternative activity paths. This process can be understood in terms of prediction-error monitoring and the perception-action loop. When the actual sensory input differs from the predicted input (i.e., prediction error), it triggers a reassessment of the situation. Minor prediction errors may lead to simple retrying of actions, while significant prediction errors necessitate a more substantial reevaluation and reorientation, potentially leading to micro-decisions.

This process is illustrated in Figure 35. The flowchart (right) depicts the DM process in response to prediction errors. When an action is performed, the actual sensory input is compared to the predicted input. If there is no significant prediction error, the activity continues smoothly. However, if a prediction error is detected, the individual may first attempt to retry the action. If retrying resolves the issue, the activity can continue. If not, a more substantial reevaluation and reorientation process is triggered, potentially leading to a micro-decision about whether to continue the activity with a new approach or to abandon it altogether.

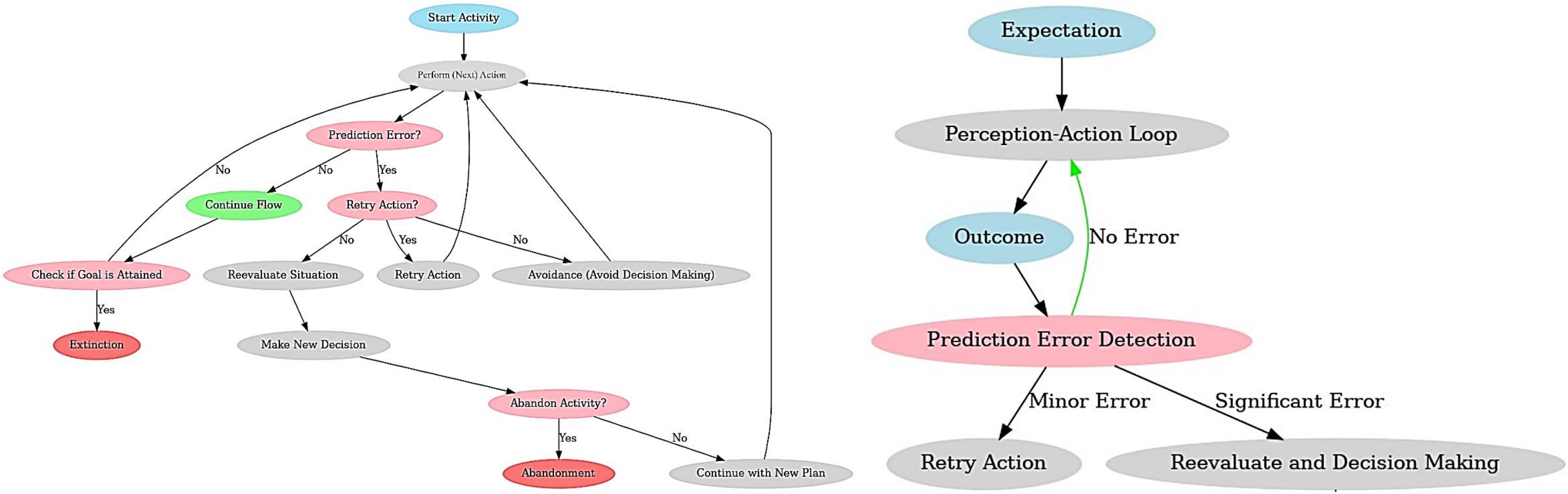
The model on the right further elaborates on the role of prediction error detection in the perception-action loop and DM. It emphasises the distinction between minor errors that lead to retrying actions and significant errors that necessitate reevaluation and reorientation and potentially lead to micro-decisions.

These models and findings provide a framework for understanding the complex interplay between perception, action, prediction, and DM in everyday activities. They highlight the continuous nature of monitoring and adjustment that characterises much of human behaviour, and they underscore the importance of considering the context and dynamics of activity flow when studying DM processes.

In the next section, we further explore these models and their implications for understanding the situated and embodied nature of MDM in everyday life.

Figure 35

Flowchart (left) illustrates the activity process and model (right) shows the perception-action loop



6.5 TOWARDS A NON-LINEAR MODEL OF MDM

The two models presented in our research, which visualise the process of MDM in everyday life, offer a novel perspective on DM that both aligns with and extends existing theories and frameworks in the literature.

Our proposed model of MDM in everyday life aligns with existing theories of self-regulation and goal-directed behaviour, such as Control Theory (Carver & Scheier, 1982) and Goal Setting Theory (Locke & Latham, 1990). However, our model extends these theories by providing a more fine-grained account of the micro-level processes that unfold during episodes of disruption and reorientation. Furthermore, our model highlights the critical role of environmental affordances (Gibson, 1986) and embodied competencies (Dreyfus, 2002) in shaping the MDM process.

One of the most striking insights from our research is the remarkable similarity between the MDM processes we observed in humans and the error correction mechanisms employed in machine learning to train AI models. The core principle underlying many AI learning algorithms, particularly those based on reinforcement learning, is the detection and correction of prediction errors (Neftci & Averbeck, 2019; Sutton & Barto, 2018).

In these models, the AI agent continuously compares its predicted outcomes to the actual outcomes it experiences in its environment. When a discrepancy (i.e., a prediction error) is detected, the agent adjusts its internal representations and DM strategies to minimise future errors and optimise its performance. This iterative process of prediction, error detection, and correction allows the AI model to gradually learn and adapt to its data, much like humans do in the course of their everyday activities.

The parallels between our proposed model of MDM (Figure 35) and machine learning error correction algorithms are striking. In both cases, the MDM process is driven by a continuous comparison of expected and actual outcomes, with discrepancies triggering a re-evaluation, reorientation and adjustment of MDM. Just as humans may retry an action in response to a minor prediction error or engage in more deliberate MDM in response to a significant error, AI models may adjust their behaviour incrementally in response to small discrepancies or make more substantial updates to their internal models in response to larger errors.

Moreover, just as our model highlights the role of environmental affordances and embodied competencies in shaping human MDM, many contemporary AI architectures, such as those based on deep reinforcement learning (Mnih et al., 2015) or embodied cognition (Pfeifer & Bongard, 2006), emphasise the importance of grounding learning and DM in the agent's sensorimotor interactions with its environment.

These parallels between human and AI DM processes underscore the fundamental role of prediction, error detection, and correction in intelligent behaviour and suggest that insights from our research on MDM in everyday life may have important implications for the design and development of more human-like and adaptable AI systems. By better understanding how humans navigate the challenges of real-world DM, we may be able to create AI agents that can more effectively learn from their experiences, adapt to novel situations, and interact with humans in more natural and intuitive ways.

At the same time, the parallels between human and AI DM processes also raise important questions about the nature of intelligence and the relationship between biological and artificial cognition. As we continue to explore the mechanisms underlying human DM and develop increasingly sophisticated AI systems, it will be crucial to consider the ethical, social, and philosophical implications of these developments and to strive for a deeper understanding of what it means to be an intelligent, adaptive agent in a complex and ever-changing world.

Dual-process theories, such as the System 1/System 2 model (Kahneman, 2011) and the Heuristic-Analytic Theory (Evans, 2006), have been influential in the study of DM. These theories propose that there are two distinct modes of cognitive processing: a fast, automatic, and intuitive mode (System 1 or heuristic processing) and a slow, deliberate, and analytical mode (System 2 or analytic processing). Our models align with dual-process theories to some extent in acknowledging the role of both automatic and controlled processes in DM. The "Retry" pathway in our models can be seen as a manifestation of System 1 processing, where individuals rely on habitual or intuitive responses to navigate minor disruptions or challenges. In contrast, the "Reevaluate" pathway, which leads to the MDM loop, can be seen as a shift towards System 2 processing, where individuals engage in more deliberate and effortful analysis of the situation.

However, our models also extend dual-process theories in several ways. First, they provide a more granular and context-specific account of how individuals switch between different modes of processing in response to the demands and affordances of their environment. Second, they highlight the role of embodied and situated factors, such as physical actions and environmental cues, in shaping DM processes. Finally, they suggest that the distinction between automatic and controlled processing may be more fluid and context-dependent than previously assumed, with individuals often engaging in hybrid or intermediate forms of processing.

Our models also share some key features with the NDM framework (Klein, 2008; Lipshitz et al., 2001), which emphasises the role of expertise, context, and adaptive strategies in real-world DM. Like NDM, our models highlight the importance of studying DM in naturalistic settings and attending to the ways in which individuals use their experience and knowledge to navigate complex and dynamic situations. The "Retry" pathway in our models can be seen as a form of "recognition-primed decision-making" (Klein, 1993), where individuals rely on their past experiences and intuitions to quickly generate and implement a course of action. If the goal is not attained, the action is performed again.

However, our models also extend the NDM framework in several ways. First, they provide a more detailed account of the micro-level processes and strategies that individuals use to adapt to disruptions and challenges in their everyday activities. Second, they highlight the role of affective and motivational factors in shaping individuals' responses to decision points, such as the cognitive and emotional costs of engaging in effortful DM. Finally, they suggest that expertise and adaptive strategies may not always be sufficient for navigating the complexities of everyday life, with individuals sometimes needing to engage in more deliberate and analytical forms of processing.

Our models also resonate with the ecological rationality perspective (Gigerenzer & Todd, 1999; Todd & Brighton, 2016), which emphasises the role of environmental structure and adaptive heuristics in DM. Like ecological rationality, our models highlight the importance of attending to the specific features and demands of the decision context rather than assuming a universal or optimal strategy for DM. The "Identify Possibilities" and "Create Possibilities" pathways in our models can be seen as forms of "simple heuristics that make us smart" (Gigerenzer & Todd, 1999), where individuals use efficient and context-specific strategies to generate and evaluate options for action.

However, our models also extend the ecological rationality perspective in several ways. First, they provide a more dynamic and process-oriented account of how individuals adapt their DM strategies to the changing demands of their environment. Second, they highlight the role of individual differences and subjective experiences in shaping DM processes rather than assuming a one-size-fits-all approach. Finally, they suggest that heuristics and environmental cues may not always be sufficient for navigating the complexities of everyday life, with individuals sometimes needing to engage in more deliberate and creative forms of problem-solving.

Our models also align with the situated cognition perspective (Hollan et al., 2000; Hutchins, 1995; Suchman, 1987), which emphasises the role of social, cultural, and material contexts in shaping cognitive processes. Like situated cognition, our models highlight the importance of studying DM as it unfolds in real-world contexts rather than assuming a purely internal or abstract process. The “Scan”, “Identify Possibilities”, and “Create Possibilities” pathways in our models can be seen as forms by which "distributed cognition" (Hutchins, 1991) or "extended mind" (Clark, 1998) operate, where individuals use external resources and cues to scaffold and support their DM processes.

However, our models also extend the situated cognition perspective in several ways:

1. Micro-level decision processes: While situated cognition emphasizes the importance of context, our models provide a more fine-grained account of the MDM processes that occur within these contexts. We identify specific behaviours like “Scan”, “Hesitation”, and “Retry”, which illustrate how individuals actively engage with their environment during DM.
2. Integration of internal and external factors: Our models shed empirical light on the dynamic interplay between internal cognitive processes and external environmental cues. For instance, the “Create Possibilities” pathway shows concretely how individuals not only respond to their environment but also actively reshape it through their decisions and actions.
3. Temporal dynamics of DM: We highlight the temporal aspect of DM in everyday contexts, showing how individuals shift between different decision strategies (e.g., from automatic to more deliberative processes) as situations evolve.
4. Role of subjective experience: Our research emphasises the importance of subjective experiences in shaping DM processes. We show how individuals' perceptions of their own DM (e.g., whether they consider an action a “decision” or not) influence their behaviour, adding a layer of complexity to the situated cognition framework.

These extensions provide a more comprehensive understanding of how individuals navigate the complexities of everyday life, balancing situated and embodied factors with more abstract reasoning processes when necessary.

Our proposed models of MDM in everyday life also share some interesting parallels with recent developments in AI and ML, particularly in the areas of reinforcement learning, adaptive control, and predictive processing. These ML processes also operate on the principle of prediction-error detection and fixing.

Reinforcement Learning (RL) is a framework in which an agent learns to make decisions by interacting with its environment and receiving rewards or punishments for its actions (Sutton & Barto, 2018). The core mechanism of RL, which involves the iterative updating of an agent's DM policy based on the outcomes of its actions, shares some similarities with the feedback loop structure of our models, especially prediction-error detection. In both cases, the DM process is driven by a comparison between expected and actual outcomes, with discrepancies or prediction errors serving as a signal for updating or revising one's strategy.

However, our models also highlight some key differences between human and machine DM. First, while RL agents typically operate in well-defined and constrained environments with clear reward signals, human decision-makers must navigate the open-ended and ambiguous contexts of everyday life, where the consequences of one's actions may be delayed, indirect, or difficult to interpret. Second, while RL agents are often driven by the maximisation of expected rewards, human decision-makers are influenced by a wide range of cognitive, affective, and social factors that may not be reducible to a simple objective function. Finally, while RL agents typically rely on extensive trial-and-error learning to converge on an optimal policy, human decision-makers can draw on their prior knowledge, experience, and intuitions to quickly generate and evaluate options for action.

Another relevant connection between our models and AI/ML is the framework of adaptive control and predictive processing (Clark, 2013; Friston, 2010). These approaches view the brain as a hierarchical system that generates predictions about the world and adjusts these predictions based on sensory feedback and prediction errors. The goal of the system is to minimize surprise or uncertainty by continuously updating its internal models to better match the structure of the environment. This perspective shares some similarities with the "prediction error" mechanism in our models, where individuals compare their expected and actual outcomes and adjust their strategies or expectations accordingly.

However, our models also highlight some key differences between human and machine prediction and control. First, while AI/ML systems typically operate on raw sensory data or low-level features, human decision-makers have access to rich, high-level representations and abstractions that allow them to reason about the world in more flexible and context-sensitive ways. Second, while AI/ML systems are often designed to optimise a specific objective or performance metric, human decision-makers must balance a wide range of competing goals, values, and constraints that may not be explicitly represented or quantified. Finally, while AI/ML systems typically update their predictions and models in a purely data-driven or bottom-up fashion, human decision-makers can also draw on their top-down knowledge, beliefs, and expectations to guide their interpretation of sensory data and their generation of predictions.

Despite these differences, the parallels between our models and AI/ML frameworks suggest that there may be some common computational principles underlying both human and machine DM. For example, the idea of minimising prediction error or surprise appears to be a powerful organising principle for both biological and artificial intelligence (Friston, 2010; Hohwy, 2013). Similarly, the use of hierarchical, feedback-driven architectures for prediction and control seems to be a recurrent motif in both natural and artificial systems (Clark, 2013; Rao & Ballard, 1999).

These parallels also raise some intriguing questions and opportunities for future research. For example, how might insights from human DM in everyday life inform the design of more flexible, adaptive, and context-sensitive AI systems? Conversely, how might the formal models and computational tools of AI/ML help us to better understand and predict human DM in real-world contexts? By exploring these questions and building bridges between the study of natural and artificial intelligence, we may be able to develop a more unified and powerful framework for understanding the nature of adaptive DM in both humans and machines.

Finally, our models share some key features with cybernetic models of DM and action regulation (Carver & Scheier, 1998; Powers, 1973), which emphasise the role of feedback, goals, and adaptive control in human behaviour. The core mechanism of our models, which involves the continuous comparison of expected and actual outcomes, aligns with the basic feedback loop structure of cybernetic models. The "Abandon" and "Continue with New Plan" (see Figure 35) pathways in our models can be seen as forms of "discrepancy reduction" (Carver & Scheier, 1998) or "error correction" (Powers, 1973), where individuals adjust their goals or strategies in response to perceived mismatches between their current state and desired end state.

However, our models also extend cybernetic models in several ways. First, they provide a more nuanced and context-specific account of the factors that shape individuals' goals, expectations, and perceptions of discrepancy. Second, they highlight the role of affective, motivational, and social factors in shaping DM processes rather than assuming a purely cognitive or computational approach. Finally, they suggest that feedback and control processes may not always be sufficient for navigating the complexities of everyday life, with individuals sometimes needing to engage in more exploratory, creative, or open-ended forms of problem-solving.

It is important to address the generalisability and falsifiability of our findings and proposed model. Our research, grounded in naturalistic observations of everyday activities, is primarily descriptive rather than predictive in nature. The models and findings presented here offer a detailed account of how MDM unfolds in real-world contexts, providing rich insights into the processes and factors involved. However, they are not intended to generate highly generalisable or predictive insights in the same way that more controlled, experimental studies might. Instead, they offer a framework for understanding the complexity and context-dependency of everyday DM.

The descriptive nature of our findings aligns with the exploratory and qualitative aspects of our methodology. While this approach allows for a nuanced understanding of DM processes, it also presents challenges in terms of traditional notions of falsifiability. Our models and findings cannot be 'proven' or 'disproven' in a strict positivist sense. Instead, they can be evaluated based on their explanatory power, coherence with existing theories, and ability to account for observed phenomena.

Further testing and refinement of our findings could involve several approaches. Quantitative studies could attempt to operationalise some of our observed variables and test for correlations or patterns across larger samples. Experimental studies could isolate specific aspects of our model to test under more controlled conditions. Additionally, longitudinal studies could explore how these MDM processes evolve over time or in response to different life circumstances.

Ultimately, the value of our findings lies in their ability to provide a rich, contextual understanding of everyday DM, offering a complement to more reductionist or generalised models. They serve as a foundation for future research, providing detailed observations and conceptual frameworks that can guide more targeted investigations into specific aspects of MDM in everyday life.In summary, our proposed models of MDM in everyday life both align with and extend existing theories and frameworks in the DM literature. By providing a situated, embodied, and process-oriented account of how individuals navigate the challenges and opportunities of their daily environments, our models contribute to the development of a more integrative and ecologically valid understanding of DM in the wild.

7 IMPLICATIONS AND LIMITATIONS

7.1 RESEARCH IMPLICATIONS AND FUTURE PATHWAYS

The comprehensive examination of MDM models, enriched by empirical, theoretical, and methodological insights, casts a wide net of implications for science, practical applications, and DM strategies. This synthesis of findings elucidates the intricate dance between cognitive processes, behavioural responses, and environmental interactions that underpin human DM.

7.2 SCIENTIFIC IMPLICATIONS:

7.2.1 Advancing Transdisciplinary Research

The integration of cognitive science, neuroscience, behavioural science, and applied psychology underscores the necessity for interdisciplinary approaches to fully grasp the complexity of DM. This research encourages a cross-pollination of ideas and methods, paving the way for innovative research paradigms that can tackle the multifaceted nature of human cognition and behaviour. our study highlights the value of using novel methodologies, such as SEBE, to capture MDM processes in naturalistic settings. By combining objective behavioural data with subjective experience, SEBE allows for a more comprehensive understanding of how people make decisions in their daily lives.

Future research should continue to explore the use of innovative methodologies to study MDM, such as experience sampling, mobile sensing, and virtual reality (Csikszentmihalyi & Larson, 1987; Harari et al., 2016b; Schulte-Mecklenbeck et al., 2017). Future studies should investigate how cultural contexts influence the DM process across the various identified MDM models and their components. Understanding cultural differences in how disruptions are perceived and managed can enrich global perspectives on DM strategies. Moreover, integrating insights from behavioural economics to explore how biases and heuristics influence MDM at each stage of the model could offer valuable perspectives on improving DM and MDM accuracy and efficiency. Additionally, further research is needed to dissect the impact of environmental and social factors on DM. This includes studying how physical environments and social networks influence the flow of activities and the responses to disruptions. Finally, employing interdisciplinary and transdisciplinary methodologies that combine qualitative and quantitative approaches can offer a more nuanced understanding of DM processes. This could involve mixed-methods research that captures the complexity of human behaviour and DM.

7.2.2 Enhancing Theoretical Models

The nuanced understanding of MDM components—from initiation to extinction—challenges and refines existing theoretical models. It highlights the dynamic, non-linear nature of DM, advocating for the development of models that more accurately reflect the interplay between internal motivations, cognitive processes, and external influences. It also suggests that DM should be studied within the context of activity as opposed to an isolated phenomenon which can be studied in simplified laboratory environments. There is a need for longitudinal research to track DM processes over time, particularly through disruptions and reorientation phases. Such studies can offer insights into how MDM and DM strategies evolve and how long-term outcomes are affected by decisions made at different stages. Implementing longitudinal studies to track DM processes over time in individuals with cognitive and mental disorders can provide insights into how DM evolves with treatment, therapy, or as a result of learning and adaptation. This long-term perspective is crucial for understanding the efficacy of interventions and support mechanisms. Moreover, investigating the role of technology in supporting DM across various activity types presents a promising avenue. Future research could focus on designing and testing digital tools or platforms that assist individuals in navigating disruptions, reorienting, and effectively implementing shifts in their DM processes. Utilising the unique methodology, future research can explore the development and testing of technology-enabled interventions aimed at supporting DM in individuals with cognitive and mental disorders. Digital tools and platforms can be designed to provide personalised support, enhancing DM autonomy and effectiveness.

7.3 IMPLICATIONS FOR COGNITIVE AND APPLIED PSYCHOLOGY

The theoretical insights garnered from this study have broad implications for both cognitive psychology and applied fields. Recognising the pervasive nature of MDM and its embeddedness within a decision ecology can inform the development of more nuanced models of DM that better reflect the complexity of human behaviour. Furthermore, these insights can be leveraged in applied settings, such as in designing environments, tools, and interventions that support efficient and effective DM in daily life. Our findings on the role of cognitive, emotional, and contextual factors in MDM underscore the importance of developing integrative models and theories that account for the complex interplay of these factors. Future research should aim to bridge the gap between traditional DM research and newer approaches, such as

NDM and ecological rationality, to develop more comprehensive and context-sensitive models of MDM. Exploring the influence of emotional and psychological states, such as stress, anxiety, and motivation, on DM processes across the model’s stages could provide insights into how these states facilitate or hinder effective DM.

7.3.1 Designing Effective Interventions

The insights gained from examining the disruption and reorientation stages offer valuable guidance for designing behavioural interventions. By understanding how individuals navigate challenges and adjust their strategies, practitioners can create targeted interventions that support resilience, adaptability, and effective problem-solving in various contexts, including healthcare, education, and workplace settings.

7.3.2 Improving Technology and Tools

The research has implications for the design of technology and digital tools that facilitate DM. User interfaces can be optimised to support the fluid flow of activities, while features can be implemented to assist users during disruptions, helping them to reorient and adjust their strategies more seamlessly (Lahlou, 2024).

7.3.3 Enhancing Decision Support Systems

The findings can inform the development of decision support systems that better accommodate the complexities of human DM. By incorporating insights into how decisions evolve across different stages, these systems can offer more nuanced support, from goal initiation to dealing with disruptions and making strategic shifts. Developing and testing adaptive decision support systems that can dynamically respond to users' needs, considering the various activity types and MDM components, could revolutionise how individuals and organisations approach DM. our study has implications for the development of interventions and DM support systems to improve everyday DM. By identifying the key behavioural variables and contextual factors that influence MDM, our findings can inform the design of targeted interventions that address the specific challenges and biases that individuals face in their daily decision processes. For example, decision aids that help individuals recognise and manage emotional trade-off difficulty or tools that provide personalised feedback based on individual differences in MDM processes could be developed based on our findings.

7.3.4 Informing Policy and Organisational Change

Understanding the components of MDM and its various types and models has direct implications for policy-making and organisational change efforts. Policies and organisational structures can be designed to minimise unnecessary disruptions, support effective reorientation strategies, and foster environments that facilitate the successful continuation or appropriate conclusion of activities.

7.3.5 Supporting Behavioural Change

The model's insights into DM processes can guide the design of programs aimed at promoting healthy behaviours or mitigating undesirable ones. By acknowledging the complexity of behavioural change, strategies can be tailored to address the specific challenges individuals face at different stages of MDM. Researching the application of the MDM models and activity types in practical settings, such as healthcare, education, and organisational management, can test the model's utility in real-world DM scenarios and inform the development of implementation strategies.

Exploring the MDM models offers profound insights that transcend disciplinary boundaries. It offers a richer understanding of DM that has far-reaching implications for science, practical applications, and the enhancement of DM strategies. This research not only contributes to the academic discourse but also provides tangible pathways for applying these insights to improve individual and collective DM outcomes in real-world contexts.

Future research should aim to further elucidate the mechanisms underlying MDM, exploring how cognitive processes such as attention, memory, and executive function interact within the decision ecology. Additionally, the role of affective states and their influence on MDM represents a promising area for exploration. Employing interdisciplinary approaches that combine cognitive psychology, behavioural science, and neuroscience could offer deeper insights into the multifaceted nature of DM and MDM in everyday life.

7.4 RESEARCH LIMITATIONS

Having explored the multifaceted activity components and typology, the MDM models, and their intricate interplay with various theoretical frameworks, we transition to a critical examination of the limitations inherent in the current research. However, like any scholarly endeavour, this analysis is subject to certain constraints that stem from methodological choices, theoretical scope, and empirical coverage. These limitations, while highlighting areas for further inquiry, also underscore the provisional nature of our conclusions and the ongoing dialogue within the field. In the forthcoming section, we will delve into these limitations, reflecting on the aspects of the model that could benefit from deeper investigation or broader contextualisation, thereby setting the stage for future research directions that can build upon and refine our understanding of DM processes.

7.4.1 Sample Size and Diversity

While the study included a diverse group of participants, the sample size may limit the generalisability of the findings to broader populations. Future research could benefit from larger, more representative samples to further validate and extend the current findings.

Activity scope and distribution: The research focused primarily on a limited set of everyday activities, such as cleaning and cooking. While these activities provide valuable insights into MDM processes, it is important to acknowledge that the findings may not fully capture the dynamics of MDM in other domains or contexts. Future studies could explore MDM in a wider range of activities and settings to develop a more comprehensive understanding of its variations and commonalities.

Moreover, our distribution of activity by type does not reflect full days: there are no recordings at work, for example, and relatively few social activities. This reflects the instructions that we gave participants to record activities at home when convenient for them. While this is a limitation, a positive aspect is that we can be certain that the behaviours recorded were perfectly natural and undisturbed by the data collection process.

Empirical Breadth and Depth: While the findings offer significant insights, they are inherently limited by the scope and depth of the empirical data collected. The reliance on specific theoretical frameworks and possibly homogeneous sample populations may restrict the generalisability of the results. Future studies should aim for broader and more diverse data collection to enhance the robustness and applicability of the findings. Moreover, the type of activities we studied (mundane everyday activities such as cleaning, cooking, commuting, grocery shopping, etc.) hardly include critical issues (life or death situations, massively impactful or consequential decisions such as marriage, moving house, buying a car, or political decisions such as voting, etc.). The same type of naturalistic research should be carried out to study such decisions, even though they are rare.

7.4.2 Methodological Constraints

The methodology employed to explore each stage of the activity model, from initiation to activity extinction, may have its limitations. For instance, the use of qualitative analysis, while rich in detail, might lack the quantitative rigour needed to establish causality or generalise findings across larger populations. Combining qualitative insights with quantitative measures on full-day recordings could provide a more comprehensive understanding of DM processes. The discussion largely draws upon theoretical constructs and existing literature, potentially lacking direct empirical evidence specific to each component of activity types and MDM models. The reliance on secondary sources may limit the ability to capture the nuanced, real-world dynamics of DM processes. Future research would benefit from empirical studies designed to explore these stages in diverse contexts. Also, we studied only a few hours of participants' typical days and some intense interpersonal situations (work meetings, childcare, etc.) were not captured and studied.

Measurement and Operationalisation Issues: Accurately measuring and operationalising concepts like "disruption" or "reorientation" in empirical research can be challenging. For advancing empirical research in this area, reliable and valid measures that can capture the dynamic nature of DM must be developed.

Subjectivity of experience: Relying on participants' subjective reports of their DM experiences introduces the potential for recall bias and individual differences in introspective ability. While the video-based analysis helps mitigate these concerns, it is important to acknowledge the inherent challenges in accessing and interpreting individuals' internal cognitive processes.

Cultural and individual differences: The study was conducted in the UK, and the findings may be influenced by cultural norms, values, and practices specific to this context. Additionally, individual differences in personality, cognitive style, and DM preferences may impact the generalisability of the findings. Future research could explore cross-cultural comparisons and the role of individual differences in shaping MDM patterns.

Causal relationships: While the research identifies significant associations between contextual factors, cognitive processes, and MDM, the observational nature of the study limits the ability to establish causal relationships. Future research employing experimental manipulations or longitudinal designs could help to further elucidate the causal mechanisms underlying the observed patterns of MDM in everyday life.

7.4.3 Theoretical and Conceptual Challenges

Interdisciplinary Integration: The effort to integrate insights from cognitive science, behavioural science, applied psychology, and neuroscience, among others, provides a multidimensional view of DM. However, this interdisciplinary approach also introduces complexity in synthesising findings cohesively. Discrepancies in terminology, conceptual frameworks, and methodological approaches across disciplines can lead to challenges in forming a unified theoretical narrative. While the analysis benefits from insights across cognitive science, behavioural science, applied psychology, neuroscience, Activity Theory, and Installation Theory, fully integrating these diverse perspectives into a cohesive understanding of DM remains challenging. Terminological differences and conceptual variances across disciplines may impede the synthesis of a unified model. The main issue here results from the research gap: the phenomena we studied have not been studied ever before in any other fields due to a lack of data and empirical issues, which we addressed through our research design and methodology.

Longitudinal Dynamics: The analysis predominantly captures a snapshot of DM processes within the defined stages of the activity model. However, DM is a dynamic process that unfolds over time. The longitudinal aspects of how decisions evolve, particularly in response to changing circumstances or new information, may not be fully addressed. Future research could benefit from longitudinal studies that track DM processes over time.

Learning: The current model does not explicitly address how learning from past experiences influences DM in subsequent stages. Learning is a fundamental aspect that can significantly impact how individuals approach disruptions, evaluate options during reorientation, and shift their goals or strategies. Incorporating learning mechanisms into the model can provide a deeper understanding of adaptive DM over time.

Time: The temporal aspect of DM and MDM is another dimension that requires further exploration. Time can affect the DM process at multiple levels, from immediate responses to disruptions to long-term strategic planning. The influence of time pressure on decision quality, as well as the role of temporal distance in goal setting and achievement, are important factors that need to be integrated into the model.

Model Flexibility and Variability: While our models (see Figure 32) provide a useful framework for understanding MDM processes, they have inherent limitations in capturing the full complexity and variability of real-world DM. As our transition tables (see Table 8) demonstrate, the sequences and patterns of reorientation and DM behaviours are not always consistent or linear. The organisation and sequence of steps in our models may vary depending on the specific situation, individual differences, and contextual factors. For instance, our transition tables show that not all pathways occur with 100% consistency, and some sequences may be more prevalent in certain activities or contexts than others. This variability suggests that a more dynamic and flexible representation might be necessary to fully capture the nuances of MDM in everyday life. Furthermore, the box-and-arrow format of our models may oversimplify DM processes. Future research should consider developing more adaptable models that can account for this variability and complexity. This might involve incorporating probabilistic elements, feedback loops, or even dynamic visualisation techniques that can better represent the fluid and context-dependent nature of MDM processes.

7.4.4 Contextual and Environmental Factors

Cultural and individual differences: The study was conducted in the United Kingdom, and the findings may be influenced by cultural norms, values, and practices specific to this context. Additionally, individual differences in personality, cognitive style, and DM preferences may impact the generalisability of the findings. Future research could explore cross-cultural comparisons and the role of individual differences in shaping MDM patterns.

Cultural and Contextual Factors: The research's findings, while insightful, may not fully account for the impact of cultural and contextual variability on DM processes. Decisions are deeply influenced by cultural norms, individual backgrounds, and specific situational contexts, which may not be adequately represented in the study. Incorporating a more diverse cultural and contextual perspective is essential for a holistic understanding of DM.

Technological and Environmental Changes: The rapid pace of technological advancement and environmental changes limits current research. As DM contexts evolve, particularly with the increased integration of digital technologies, the applicability of the findings may need continuous re-evaluation.

Collaboration: The activity model primarily focuses on individual DM and MDM processes. However, many real-world decisions are made in collaborative settings, where multiple actors contribute to the DM process. Future research should explore how collaboration influences the dynamics of each stage in the model, including how collective DM navigates disruptions and reorientations. The interplay between individual and group goals, as well as the mechanisms for resolving conflicts and achieving consensus, remains a critical area for further investigation.

Cognitive and/or Mental Disorders: The model's applicability to individuals with cognitive or mental disorders (e.g., ADHD) presents a significant limitation. These individuals may experience disruptions, reorientations, and shifts in DM processes differently due to variations in cognitive functioning, emotional regulation, and social interaction. Research exploring DM in populations with cognitive and/or mental disorders can shed light on the need for tailored interventions and support mechanisms that address these unique challenges.

7.4.5 Practical Application and Implementation

Translating theoretical insights and empirical findings into practical applications poses a challenge. While the research sheds light on the complexities of DM, developing interventions, tools, or strategies based on these insights requires careful consideration of practicality, usability, and effectiveness in real-world settings.

Our findings and discussion provide valuable contributions to understanding DM processes within the activity and MDM model framework. However, acknowledging these limitations is crucial for guiding future research directions, enhancing methodological rigour, and ensuring the findings' relevance and applicability in diverse and evolving DM contexts. Addressing these limitations through targeted empirical studies, interdisciplinary collaboration, and the exploration of practical applications will be crucial for advancing our understanding of DM in complex environments.

8 CONCLUSIONS

We captured and analysed first-person video recordings of free-ranging participants' daily activities in a naturalistic context, conducted self-confrontation interviews, and developed a novel coding system (RRIW) to identify instances of MDM. By combining detailed ethnographic observations with participants' subjective experiences, this research has provided valuable insights into the cognitive, emotional, and contextual factors that shape decision processes in naturalistic settings.

This approach has provided a more ecologically valid and fine-grained account of the processes and strategies that individuals employ when making micro-decisions in real-world contexts. The findings challenge simplistic models of human behaviour and DM, highlighting the complex, context-dependent, and often low-level nature of MDM in daily life.

This research also provides, for the first time, detailed statistics about the behaviours involved in NDM, with a sample of some 2302 moments described as micro-decisions by the actors themselves.

The high frequency of breaks in activity flow and the prevalence of MDM in these moments underscore the continuous negotiation and DM that individuals engage in as they navigate their everyday tasks. However, the nature of these micro-decisions appears to be more often oriented towards low-level comparisons of affordances, pragmatic subgoals, and cost-benefit evaluations rather than the deliberative, rational analysis often assumed in DM literature.

Below, we list some of our key findings:

1. MDM in everyday life is a complex, dynamic, and context-dependent process that involves a wide range of behavioural variables, such as pausing, hesitation, scanning, retrying, and giving up. These variables were found to be significantly associated with instances of MDM, with p-values indicating strong evidence against the null hypothesis. Moreover, the study revealed that the frequency and nature of MDM varied across different everyday activities, with some activities (e.g., cleaning, cooking) involving more frequent and deliberate MDM than others (e.g., commuting). Such activities were found to be massively guided by the installation, which supports the activities and strongly regulates behaviour, so much so that only possible course of action remains, ultimately relieving the participant from the need to make any decisions.

2. High frequency of micro-decisions: The study revealed that individuals make micro-decisions at a high frequency during everyday activities, with an average of one micro-decision every 1 minute and 26 seconds. This finding highlights the prevalence of such decisions in daily life and challenges the notion that everyday activities are performed in a purely automatic or mindless manner.
3. Contextual influence on MDM: The physical environment, psychological state, and social context significantly influence the frequency and nature of MDM. This finding emphasises the importance of considering the decision ecology and the context of activity when studying DM processes and suggests that the number of daily decisions varies depending on the individual's environment and activities.
4. Low-level nature of micro-decisions: A significant proportion of micro-decisions in everyday activities involve low-level comparisons of affordances, pragmatic subgoals, and cost-benefit evaluations rather than deliberative, rational analysis. This finding challenges traditional models of DM and highlights the need for theories that account for the situated and embodied nature of MDM in real-world contexts.
5. Disruptions prompt reorientation and micro-decisions: Disruptions in the activity flow, such as prediction errors or unexpected events, prompt reorientation and potentially lead to micro-decisions. This finding is supported by neuroscience research demonstrating how unexpected stimuli can trigger neural processes associated with attention redirection and DM.
6. Retrying actions and reevaluating situations: When faced with prediction errors, individuals may first attempt to retry their actions. If retrying does not resolve the issue, a more substantial re-evaluation and reorientation process is triggered, potentially leading to a micro-decision about whether to continue the activity with a new approach or to abandon it altogether.
7. Perception-action loop and error prediction: The study highlights the role of error prediction and the perception-action loop in guiding behaviour and DM. Minor prediction errors may lead to simple retrying of actions, while significant prediction errors necessitate a more substantial re-evaluation and reorientation, potentially leading to subjective experiences of making a micro-decision.
8. Behavioural events indicating MDM: The study identified several behavioural events, such as pausing, hesitation, and scanning, that are related with MDM. These observable variables not only indicate the presence of micro-decision instances but also suggest a

level of cognitive engagement and evaluation that goes beyond automatic or habitual responses.

9. Novel methodology: The research employed a novel combination of ethnographic observations, subjective experience sampling, and video-based analysis to study MDM in naturalistic settings. This methodology offers a promising approach for investigating DM and other cognitive processes in real-world contexts.

These findings contribute to a more comprehensive and ecologically valid understanding of human DM, emphasising the importance of studying MDM as it unfolds in the complex, dynamic contexts of everyday life. The insights gained from this research have important implications for DM theories, user experience design, behavioural interventions, and decision support systems.

Our findings confirm, extend, and refine several aspects of Activity Theory and Installation Theory. They emphasise but also describe in great detail the critical role of the decision ecology—the physical, psychological, and social contexts—in shaping the frequency and nature of MDM. This contextual influence underscores the importance of considering the situated and embodied nature of DM processes, as well as the role of error prediction and the perception-action loop in guiding behaviour.

The embodied nature of the DM processes observed in this study has important implications for theories of embodied cognition more generally. The findings from this study provide support for theories of embodied cognition, which propose that cognitive processes are deeply rooted in the body's interactions with the world (Wilson, 2002). Many of the DM scenarios observed in this research involved considering or executing physical actions, such as reaching for objects, navigating spaces, or manipulating tools.

The reliance on bodily sensations, physical affordances, and action simulation in arriving at decisions aligns with the central premise of embodied cognition - that the mind is not merely an abstract information processor but rather is shaped by the body and its engagements with the surrounding environment (Shapiro, 2019). Participants frequently “thought through” decisions by imagining how actions would feel or play out, underscoring the importance of sensorimotor processes in cognition.

Furthermore, the context-dependent nature of many decisions, tied to the specific physical environment and objects at hand, suggests that thinking is situated and embodied rather than purely abstract (Smith & Semin, 2004). The actionable properties of objects and spaces appeared to actively guide and constrain DM. This supports an ecological view of embodied cognition, where cognitive processes are deeply entwined with affordances in the local environment (Gibson, 1979).

Several patterns in our data illustrate how DM drew upon embodied and situated cognitive processes. For example:

Physical Affordances:

- Participants frequently considered the physical properties and affordances of objects when deciding how to use them. For example, the shape, size and material of a tool constrained the actions participants attempted.
- The spatial layout and arrangement of the environment influenced navigation-related decisions. Participants used perceptual cues like obstacles, openings and surfaces to guide route planning.

Action Simulation:

- When deciding between alternative actions, participants often imaginatively simulated the bodily movements and sensations involved, such as mentally rehearsing a reaching motion or the feel of an object in the hand.
- Anticipated physical effort and motor difficulty were weighed as costs in action decisions. Participants imagined the embodied experience of performing an action when evaluating it as an option.

Contextual Sensitivity:

- Decisions were highly attuned to the specific physical and social context at hand, rather than abstract or context-general. Participants considered situational affordances and constraints.
- Similar decisions unfolded differently across contexts depending on the exact environment, objects available, and bodily states of the participant, showcasing the situated nature of cognition.

Gesture and Posture:

- Participants frequently used gestures and bodily movements like pointing, reaching or leaning when reasoning about a decision or communicating a choice, suggesting a strong link between body and thought.

- Postural shifts and bodily orientation were used to gather information and signal interest in choice alternatives, indicating an embodied mode of DM.

Sensory Engagement:

- Decisions involved active sensory probing of the environment, such as touching surfaces, sniffing objects, or shifting perspectives to gather relevant sensory data.
- This ongoing coupling between perception and action during DM exemplifies principles of embodied cognition.

These are just a few examples, but they highlight how decision processes were shaped by the body and environmental context rather than being purely abstract mental affairs. You can choose a subset of these or other compelling examples from your data. Aim to provide concrete instances for each point.

In summary, the embodied nature of real-world DM observed in this study challenges traditional cognitive models that view the mind as an abstract symbol manipulator. Instead, the findings underscore the importance of bodily states, sensorimotor simulations, and environmentally-embedded actions in shaping cognition, lending evidence to theories of embodied cognitive science. Continued research in naturalistic settings can further illuminate the embodied foundations of thought and DM.

Our findings present several challenges to existing theories and approaches discussed in the literature review. Firstly, our observation of the high frequency of micro-decisions in everyday life (one every 1 minute and 26 seconds on average) challenges the notion of purely automatic or habitual behaviour in routine activities, as suggested by some dual-process theories. The complex interplay between automatic and deliberative processes we observed suggests that the dichotomy between System 1 and System 2 thinking may be oversimplified in the context of everyday DM.

Secondly, our findings on the role of environmental affordances and embodied competencies in shaping decision processes challenge the cognitive-centric views of many traditional DM theories. The importance of physical context and bodily states in our observed decision processes aligns more closely with theories of embodied cognition and situated action than with purely cognitive models of DM.

Thirdly, our observation of the “Give Up” behaviour as sometimes representing an avoidance of DM rather than a decision itself challenges assumptions about the nature of choice in everyday contexts. This finding suggests that theories of DM need to account for the cognitive costs of decision processes and the strategies people use to avoid these costs.

Finally, our findings on the role of prediction-error monitoring in guiding everyday decisions challenge the sufficiency of both rational choice models and heuristic-based approaches. The continuous, dynamic process of comparing expectations to outcomes that we observed suggests a more fluid and adaptive model of DM than is typically captured in existing theories.

These challenges to existing theories underscore the need for more naturalistic, context-sensitive approaches to studying DM, particularly in everyday life contexts. They highlight the limitations of overly simplified or abstracted models of DM and point towards the need for theories that can account for the complex, embodied, and situated nature of everyday cognitive processes.

Finally, our research has suggested a fundamental mechanism, prediction-error monitoring, governing how individuals navigate the complex and dynamic demands of their daily activities. Our proposed model, with the hypothesis of prediction-error monitoring, centres on the continuous comparison of expectations to actual outcomes and the deployment of different strategies in response to prediction errors. It offers a new perspective on DM that both extends and challenges traditional models and highlights the importance of considering MDM's situated, embodied, and affect-driven nature.

The models and frameworks developed from our analyses provide a foundation for further research into the micro-level processes of DM in naturalistic settings. They also have important implications for fields such as cognitive psychology, behavioural economics, and user experience design, as they challenge researchers and practitioners to consider the continuous, context-dependent, and often subtle nature of MDM in their work.

While our study has limitations, it also opens up exciting avenues for future research that can further illuminate the neural, psychological, and practical dimensions of MDM.

Future research could build upon these findings by further investigating the specific types of micro-decisions made in different contexts, the role of individual differences in MDM patterns, and the potential applications of these insights in areas such as decision support systems, user interface design, and behavioural interventions.

Ultimately, we believe that our research represents an important step towards developing a more comprehensive and ecologically valid science of DM, one that recognises the inherent complexity and dynamism of real-world environments and the situated, embodied, and affective nature of human cognition. By continuing to explore the processes and strategies that individuals employ when navigating the challenges of everyday life, we can not only deepen our understanding of the human mind but also develop more effective interventions and tools for supporting adaptive DM in the wild.

Moreover, the insights gained from this research have important implications for the design of interventions, decision support systems, and choice architectures aimed at improving DM processes and outcomes in everyday life. By identifying the key behavioural variables and contextual factors associated with effective and satisfying MDM, this study provides a foundation for developing more targeted and evidence-based approaches to decision support.

As DM researchers continue to grapple with the complexity and diversity of human choice processes, the present study offers a promising new direction for future inquiry. By embracing immersive, first-person methodologies, developing new analytical techniques, and adopting a more context-sensitive and integrative approach to studying MDM, researchers can deepen their understanding of how people navigate the countless decisions that shape their daily lives. Ultimately, this understanding can contribute to the development of a more effective, equitable, and empowering science of DM, one that truly reflects the richness and diversity of human experience.

As we reflect on the contributions of this study, it becomes clear that the field of DM research stands at a critical juncture. For too long, the dominant paradigms and methodologies in this field have failed to capture the true complexity and dynamism of human choice processes, leading to models and interventions that are often ill-suited to the realities of everyday life. By challenging these paradigms and pioneering new approaches, such as SEBE and RRIW, the present study represents a clarion call for change. It is a reminder that the study of DM is not simply an academic exercise but a deeply human endeavour, one that requires us to grapple with the messy, context-dependent, and often irrational ways in which people navigate their lives. As we move forward, let us embrace this complexity and let us strive to build a science of DM that truly reflects the diversity and richness of human experience. For it is only by doing so that we can hope to unlock the full potential of this field and improve human DM as decision research once set out to do.

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APPENDIX A) PARTICIPANT INFORMATION SHEET

You are being invited to take part in a research study. Before deciding to participate it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information. Feel free to discuss issues with anyone, and if there is anything which is not clear or any questions you have, feel free to ask. Take your time reading, and don't feel rushed.

What is this research about?

In order to gain a deep understanding of what you perceive as a decision and how you experience making one, a naturalistic study of your behaviour in real-world contexts is required. The research thus attempts to investigate your subjective experience of decision-making as you engage in various everyday activities.

Who is doing this research?

My name is Atrina Oraee, I am a MSc student in the Psychology of Economic Life program of the Department of Psychological and Behavioural Science at the London School of Economics and Political Science. My dissertation project is supervised by Prof. Saadi Lahlou.

a.oraee@lse.ac.uk ; s.lahlou@lse.ac.uk

Why have you asked me to participate?

I have asked you to participate in my study because you are an active adult, aged between 22 and 65 years old who are likely to engage in various activities throughout your everyday life.

What will participation involve?

You will be given an introduction in how to use the subcam. You will then be asked to wear your subcams throughout the day doing everyday activities like studying, doing groceries, cooking, commuting, etc. You will then watch the video material you have gathered together with the researcher to explain what is going on in the subfilm.

How long will participation take?

I would like to ask you to record yourself and your everyday activities with your subcam for several hours a day over a few days. It is important that you film yourself for a longer period (5h+) at least once. You will then be asked to participate in a Replay Interview of about an hour.

What about confidentiality?

You will gather first person view, audio-visual material (subfilms) with your subcam, with the possibility to interrupt the recording whenever you might wish to do so. You will be able to preview the material before submitting it to the researcher, with the possibility of editing out unwanted passages or abandoning the entire tape altogether. It is furthermore possible to blur faces and distort or erase voices of any person that might appear in the subfilms and wishes no to.

If you are willing to participate, then please sign a Consent Form.

You can keep this Information Sheet for your records.

APPENDIX B) INFORMED CONSENT FORM

Project: Using Subjective Evidence-Based Ethnography to Investigate Micro Decision-Making in Everyday Life

Researcher: Atrina Oraee

Supervisor: Professor Saadi Lahlou

To be completed by the Research Participant

Please answer each of the following questions:

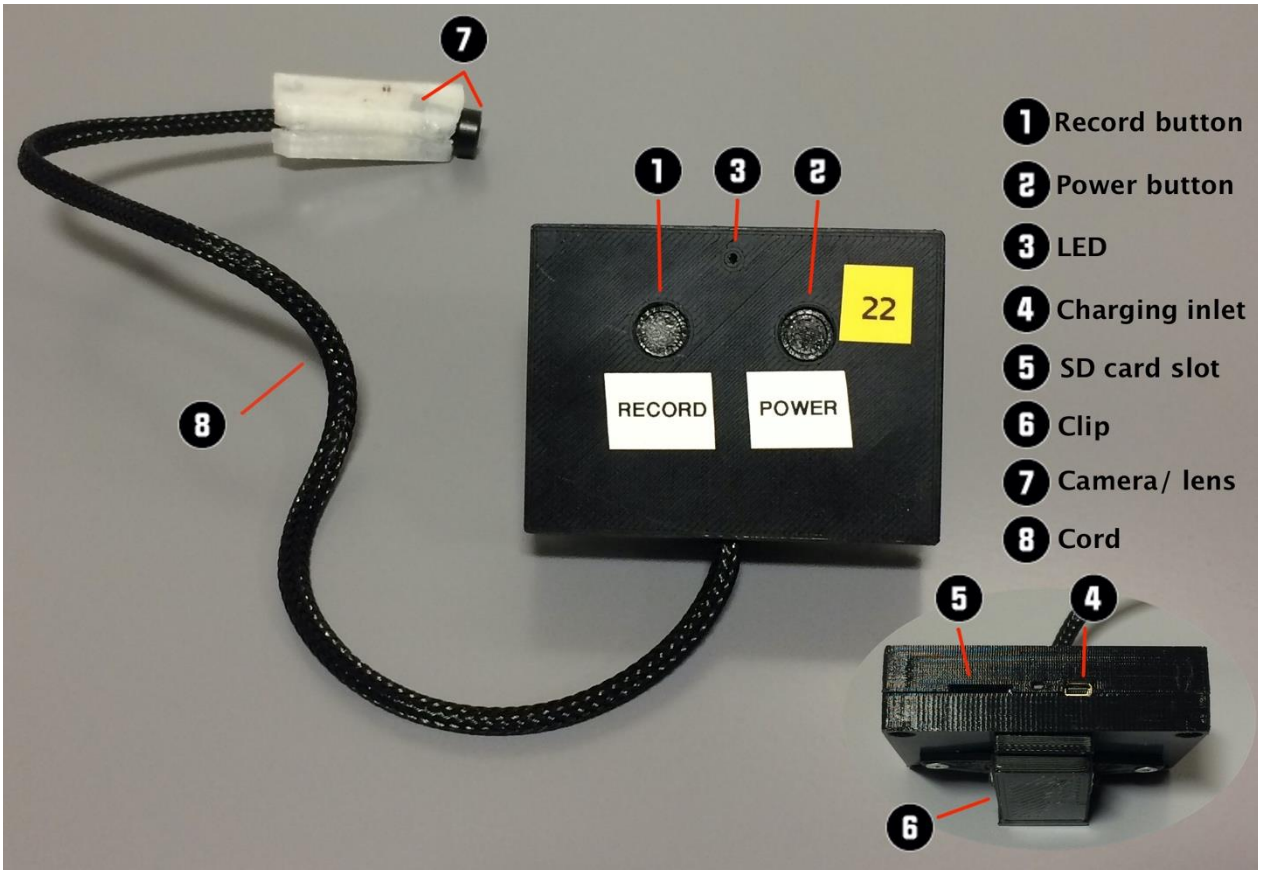
Do you feel you have been given sufficient information about the research to enable you to decide whether or not to participate in the research?	Yes	No
Have you had an opportunity to ask questions about the research?	Yes	No
Do you understand that your participation is voluntary, and that you are free to withdraw at any time, without giving a reason, and without penalty?	Yes	No
Are you willing to take part in the research?	Yes	No
Are you aware that the interview/focus group will be audio/video recorded?	Yes	No
Will you allow the researcher to use anonymized quotes in presentations and publications?	Yes	No
Will you allow the anonymized data to be archived, to enable secondary analysis and training future researchers?	Yes	No

Participants Name:_______________________________

Participant’s Signature: ___________________________ Date:__________

If you would like a copy of the research report, please provide your email or postal address:

B1) SUBCAM MANUAL



Your subcam has two buttons and one LED. Please insert an SD card into the SD card slot (5) before using the camera.

- To turn the subcam on or off, hold the power button (2) for two seconds. While on, the LED will shine an orange light. If the LED is flashing instead, please make sure you have inserted the SD card correctly.
- To record footage or to stop recording, press the record button (1). While recording, the orange LED will flash.
- To charge your subcam, plug the long-life battery into the charging inlet of your cam (4) and connect the battery to power. While charging the cam, the LED will shine a red light. Fully charged, the internal battery of your subcam lasts 3 hours (check whether this is correct). The long-life battery lasts an additional 5 hours, which gives you 8 hours of recording time in total.

APPENDIX C) LSE ETHICS BOARD APPROVAL

Oraee,A

From:	LSE Research Ethics <research.ethics@lse.ac.uk>
Sent:	12 May 2021 10:10
To:	Oraee,A (pqt)
Subject:	Ethics Approval Confirmation - An Investigation into the Subjective Experience of

Research Ethics

Dear Atrina ORAEE,

The ethics review application for the project:

An Investigation into the Subjective Experience of
Ref: 25112

has been **approved**.

The following comments from Saadi Lahlou were included:

Thank you for a thorough description and your use of the SEBE ethical guidelines

A reminder that if you will be **travelling** abroad to collect your data you must complete a Notification to Travel form. Please refer to the guidance here, and contact Health.and.Safety@lse.ac.uk if you have any questions.

If you have not already done so, we recommend you complete a **Data Management Plan** (this is mandatory for all funded research, but advisable for all research projects). Please refer to the guidance here, and contact the LSE Data Librarian if you have any questions.

You can view you application by clicking on the button below. If the circumstances of the research project change please email research.ethics@lse.ac.uk to ascertain whether any further approval is required.

If you have any further questions, please contact research.ethics@lse.ac.uk

My Research Projects

APPENDIX D) SAMPLE DATA

Two example subfilms recorded by two different participants can be viewed using the below link. The subfilm shows participants going through an activity which they perceive as part of their everyday life. The below link can also be used to access the RIW conducted with the participants. A sample of the transcript from RIWs conducted with both participants has been included in the next sub-section (see Sample Replay Interviewers).

https://drive.google.com/drive/folders/14aMWAIlWusWdnMPBrOAjd4vw4dQ3kP-q?usp=sharing

Permission to use these short clips as supplementary material for this dissertation has been obtained by the participants and all those whose voices and/or faces have appeared through the subfilms and RIWs.

D1) SAMPLE REPLAY INTERVIEWS

PARTICIPANT NUMBER: 12

PARTICIPANT INFORMATION: Female, 23

DURATION: 01:04:04

DATE & TIME: 2021-06-23 | 11:32:16

Interviewer: *Alright, so I have now started to record the session. Thanks again for your time! So, do you remember what's the goal here {00:00:01} and what you're doing?*

Participant (12): *Yeah, I've just woken up, so I was just making my bed and just doing my morning routine.*

Interviewer: *Okay, um, do you always start your morning routine with making your bed?*

Participant (12): *Yeah, I mean like, the minute I get off the bed, I need to make my bed before I start doing anything else.*

Interviewer: *Okay, did you experience making your bed as something you decided to do?*

Participant (12): *I think it's more like, something that I always do as soon as I wake up and start my day. I just do it without thinking, so I don't experience it like a decision.*

Interviewer: *Fantastic! So here {00:01:05}, what are you up to? What's the goal now?*

Participant (12): *I'm tidying up the room a bit. Just folding clothes and things like that which I left there the previous night, so I try my best to tidy up my room before I sleep, but if I'm too tired or it's too late, then I just leave it and that's [tidying up the room] the first thing I do in the morning, which is what's happening in the video here {00:01:23}.*

Interviewer: *I see. Did you experience it as a decision to tidy up the room?*

Participant (12): *It was more like, a decision I made the night before and then in the morning I just the clothes left out in the room and remembered that I need to tidy up and put them away.*

Interviewer: *Right, and how about folding the clothes and putting them back? Was this something you experienced as a decision?*

Participant (12): *For that particular morning and at that particular instance {00:01:44}, yes, considering I made the decision not to do it before I slept the previous night and leave it for the next morning. So, yeah, that activity [folding the clothes and putting them away] was based on a decision I made at that moment.*

Interviewer: *Interesting! How about where to put the clothes after you're done with folding them? Do you experience choosing where to put them as a decision, or do they have their designated place where they always go and so, you don't even need to think about it?*

Participant (12): *No, I don't decide where to put them, because everything in my room has its designated spot, so I always know where they [folded clothes] go. I don't change the spot, so I don't need to make any decisions.*

Interviewer: *Alright, fantastic! So, um, how come you went for some water here {00:02:25}? Was it because you were thirsty, or wanted to stay hydrated, or was it mostly because you saw it there and just went for it?*

Participant (12): *I think I was thirsty, because I had just woken up and I hadn't had water and also because I had to water my plants, so…*

Interviewer: *Was watering the plants something you experienced as a decision?*

Participant (12): *No, like I said, it's my morning routine and I don't usually decide on the activities that I do as part of my morning routine, so it wouldn't have been a decision.*

Interviewer: *Right, and here {00:03:09}, what happens is that your bag comes into your visual field and you then start emptying it.*

Participant (12): *Yeah, because like I said, everything in my room has a designated spot, so I always keep my bag in its place, like right now it's also there [in its designated place]. So, when I saw the bag was on the chair, I decided to move it because I was tidying up everything already and I saw the bag there and decided to put it where it should be. So, that was a decision I made on the spot after seeing the bag there while I was tidying everything up.*

Interviewer: *Interesting! Is it like, you were in some sort of a cleaning mindset, so whatever comes into your visual field that needs tidying up, you take care of it on the spot?*

Participant (12): *Yeah, I would prefer everything being in its place before I start my day, because if it's all over the place, then my mind will also feel very cluttered, so just having everything put back in its place helps me start my day nicely.*

Interviewer: *Fantastic! Yeah, that makes perfect sense. So, do you remember why you came into the kitchen here {00:04:28}?*

Participant (12): *Because I was done tidying up the room and then I came out to the kitchen to see if there was any more tidying up left to do in the kitchen and then I saw that I had left the baking tray out from the previous day, because I did some* *baking, so I just came and put back the thing. So, I was still in a cleaning mindset and generally looking for anything that needs tidying up and the baking tray came into my visual field and I was like "That doesn't belong there", so I put it back.*

Interviewer: *And did you decide on where to put the baking tray, or did you just know where it goes?*

Participant (12): *I knew where it goes, so that wasn't an issue that I needed to decide on.*

Interviewer: *Alright, and do you remember why you open the fridge here {00:05:01}?*

Participant (12): *To get the milk, because I always have milk in the morning. That's how I start my day. {00:05:15} Yeah, these were all the dishes I'd washed the previous night, so I was just putting them back as well. I saw the dishes there, so I decided I'm gonna put those away first and then have milk.*

Interviewer: *Okay, did you experience it as a decision to take care of the dishes first before going for some milk, because like, you suddenly saw the dishes there?*

Participant (12): *Yeah, that was a decision.*

Interviewer: *How about where to put them? Did you experience where to put the dishes as making a decision over?*

Participant (12): *No, they have their designated spot.*

Interviewer: *Did you experience having some milk at that moment as a decision?*

Participant (12): *No, that's always been how I start my day my entire life. {00:06:18} I'm waiting for the milk to warm up and meanwhile, I'm tidying up the kitchen.*

Interviewer: *And here {00:06:33} you see the pile of mail there and decide to shuffle through them?*

Participant (12): *Yeah, because it was just all messy there. I was just rearranging it and I was just seeing if there was any mail that concerned me, because my roommate is the one who brings the mail into the room, so I was seeing if any of them were for me.*

Interviewer: *Okay, and what's the goal here {00:07:02}?*

Participant (12): *It's to tidy up the kitchen while I wait for the milk to warm up and normally, while the milk is still warming up, I try to finish anymore work that's left, because once I'm done having milk, I just directly go take a shower.*

Interviewer: *Okay, and how do you when the milk is done warming up?*

Participant (12): *I heat it up for one minute, so the microwave beeps when the one minute is up.*

Interviewer: *Okay, okay, and in this one [recording] {00:07:52}, is the goal again to clean up the room?*

Participant (12): *Yes, again, I'm tidying up the place and this was like, a different day and after my shower.*

Interviewer: *Okay, so you're hoovering the room here {00:08:05} and I'm wondering how you know if or when the room needs some hoovering? How do you decide whether to hoover the room?*

Participant (12): *So, I try to do it twice a week, but it really depends on how the room is. If I feel like it's messy or if I can see a lot of dust on the floor and if I just feel like it needs cleaning, I just clean it, so that would be a decision that I make based on how the room looks and whether I would need to clean it.*

Interviewer: *Interesting! So, you also get some visual feedback from the state in which the room is?*

Participant (12): *Yeah, like I said, I try to hoover the room twice a week, but which day of the week in particular definitely depends on how the room looks and how satisfied I am with how clean the room is.*

Interviewer: *Okay, that's really interesting! Is choosing which day in particular to hoover something you experience as a decision?*

Participant (12): *Yeah, hundred percent. Yeah.*

Interviewer: *Okay, cool. Also, how do you know how much hoovering is enough? As in like, how do you when to stop hoovering and that it's like, enough?*

Participant (12): *I mean, I just go over the entire space and based on like, experience, it's usually pretty much clean after that. So, again, it's also visual feedback. So, it's a bit of both experience with cleaning hoovering the room many many times and also visual feedback.*

Interviewer: *Fantastic! You also hoover the kitchen. Was that always part of the plan? Do you always hoover the kitchen as well as your room?*

Participant (12): *Yeah, because I'm sort of a person who likes everything being clean, like I even hoover the bathroom, but yeah like, I need every space that I'm living in completely clean.*

Interviewer: *Yeah, I see. Also, I'm curious to know if you remember what was going on in your mind as you were hoovering. Were you thinking consciously about the task at hand, or was your mind wandering off and you were like, thinking of something else?*

Participant (12): *It's just, cleaning is very relaxing for me, so I think it was just a nice break from work and everything. It just makes me happy when I see everything clean. So, I was just smiling when I was doing this and like, enjoying it, but the other thing could have been that, because I'd just taken a shower, I was also trying* *to make a mental list of all the things I have to do. So, I was thinking about what else do I have to do that day, so [I] was just making a mental checklist as I was hoovering and was thinking ahead because the hoovering doesn't need much conscious attention of course.*

Interviewer: *That's really interesting! You mentioned a mental checklist, is this something you do every day?*

Participant (12): *Yeah, definitely! I make a mental checklist of all the things I need to do that day and then cross them off mentally one by one.*

Interviewer: *Interesting! You take a mop here {00:11:28} and mop the floors after you're done with hoovering. Is this always part of your cleaning routine? Like is it always with the same structure, like you hoover first and then mop?*

Participant (12): *Yeah, that's how I always clean. It's like, hoover first and then I mop the floors. It's not something I have to decide on really. The decision is whether to clean or not, but if I decide to clean, then this is how it's going to be.*

Interviewer: *Yeah, that makes perfect sense. Again, as you're mopping the floors here {00:12:01}, are you trying to get some visual feedback like you did with when you were hoovering the place?*

Participant (12): *Yeah, like, I go over the surfaces once and if I felt like there was the need to go over it again, based on the visual feedback, I'd go over it again but at that point I keep it at one [go]. {00:12:25} There I realised I ran out of mopping liquid, which is why I just stick to mopping my room, because otherwise I would have mopped the kitchen and the bathroom as well.*

Interviewer: *Yeah, right. Do you remember why you went in the kitchen here {00:12:35}?*

Participant (12): *Just to wash my hand up, because I was finished with the cleaning.*

Interviewer: *Was washing your hands after you were done with the hoovering and mopping something you experienced as a decision?*

Participant (12): *No, I mean, because I do it every time, I wouldn't say I felt like I decided to do it [wash hands]. I mean, especially now with Covid, you're just so prone to washing your hands after everything. So, it's mostly a habit by now that I'm so used to.*

Interviewer: *I see. So, here {00:13:20}, do you remember what's the goal and what's happening basically?*

Participant (12): *So, I go for evening walks every day, especially on the days that I'm working and I don't get to step out, I make a point to at least go to the park* *close by for an evening walk, so there {00:13:33}, I've just come for an evening walk.*

Interviewer: *Okay, do you always go to the same park for your evening park?*

Participant (12): *Yeah, I always go to the same park, but this was something that I started a week before that [the recording], to go to the park every day. So, yeah, the decision was already made to go to the park every day and then another decision here was the time, because the first time I went over [to the park] late, probably around seven thirty or eight, and I saw that there was very less crowd, very few people and it was really quiet and silent and I like that, so the time when I was going to go for a walk was a decision that I made to only go at this time, because I like how the park is at that time and I knew this based on like, experience. So, it was a decision based on trial and error and I managed to figure out the best time and decided to go only at that time to enjoy my walks even more.*

Interviewer: *Right, right. So, you prefer the park to be less crowded and you enjoy it better when there are few people around?*

Participant (12): *Yeah, because since I'm going to a walk, it's supposed to be more of a relaxing activity and not having too many people around help it being relaxing.*

Interviewer: *Yeah, that's totally relatable! Do you have a certain route in the park which you've chosen to take, or are you just randomly walking wherever?*

Participant (12): *So, the park itself has a designated path, so I just stick to that.*

Interviewer: *Oh, I see. Here {00:16:10}, another path sort of, breaks off from the one you were taking. How come you went for this one then?*

Participant (12): *That path is more for cyclists and the people who want like, a shorter walk, but I always stick to the longer route.*

Interviewer: *Okay, was that a decision you made? I mean, did you even consider at all taking the other route?*

Participant (12): *No, because, I mean I try to walk five kilometres every day, so it's just a lot easier if you take the longer route to finish it and reach my goal of 5 kilometres.*

Interviewer: *Okay, okay, and here {00:19:10}, do you remember what's happening and what's the goal?*

Participant (12): *I'm preparing lunch, so I was just washing it before cooking it.*

Interviewer: *Do you already know by now what you want to make for lunch? Was this something you experienced as a decision?*

Participant (12): *I do know what I want for lunch, yes and I definitely experienced it as a decision, because it depends on what ingredients I have, how much time do I have to cook. So, based on that, then I make a decision. Also, based on how hungry I am, do I want to make a quick snack, or do I want to make a full meal. So, I* *consider a lot of factors for the decision and so, it's definitely something I have to decide each time.*

Interviewer: *Interesting! So, the meal that you've chosen to prepare, is it based on a recipe, or do you already know how to make the chosen meal?*

Participant (12): *It [the chosen meal for lunch] was something I know how to make.*

Interviewer: *Okay, so I'm wondering if you have an image of how you want the final dish to look like, and you just aim for that and rest just comes naturally, or is like, you have certain instructions that you have to tick one by one regardless of the outcome?*

Participant (12): *Both, actually. I have a mental image of how the final dish is supposed to look like, as well as knowing the steps and instructions I have to follow, even though I don't have a recipe, because it's not the first time I was making that particular dish, so I knew based on experience what steps to take in order to reach that final image of the dish.*

Interviewer: *This is super interesting! So, do you experience choosing the ingredients for the meal as a decision, or do you already know what goes in because you've prepared this particular meal before?*

Participant (12): *So, I was making fried rice that day and because I had extra vegetables, I just decided to put extra vegetables, like I just added carrot and beans because that was all I had, but that day I also had broccoli, so I made a decision to have broccoli as well, so that was an additional decision other than putting in more vegetables.*

Interviewer: *And how come you suddenly went for washing the dishes?*

Participant (12): *Because I've put the rice on the gas and because it will take some time and since I was already in the kitchen, I thought until that cooks, I can wash the dishes.*

Interviewer: *And do you always wear the kitchen the gloves when you wash the dishes, or was something you experienced as a decision to wear them to wash the dishes?*

Participant (12): *I always wear them, so it wasn't a decision, but obviously, the first time I got them it was a decision that I made to get them so that I can start wearing them to wash [the dishes], but after a certain point it wasn't a decision I had to make anymore and I just wear them every time now.*

Interviewer: *Right, right. Is there a certain structure you have in your mind when you wash the dishes, or do you just wash them without having to think that much?*

Participant (12): *So, I think it's the way I arrange it. So, I know how the dishes fit in this space [dish rack] that I have, so I try to wash it in the same model, so for example, I always wash the cups first, because those are the ones I keep first, but if there's a plate, I wash that before I wash the cups because the plate goes behind* *the cups, so it's in the order in which I leave it to dry and I wash in that order and based on how the space [dish rack] is like, designed and how I fit the dishes in it and leave them to dry.*

Interviewer: *Okay, so here {00:22:45}, you suddenly go back to the stove to check up on the rice. I'm wondering how come you suddenly went to the stove? Did you hear some sound that it was making, or is it just like you felt an itch to check up on the rice?*

Participant (12): *Because I could see the water in boiling, so that's when I knew I had to stir the rice, otherwise based on experience I know that the rice which was at the bottom would cook more than it is on the top, so I was just stirring it.*

Interviewer: *Alright. Again {00:24:14} here, you check up on the rice again.*

Participant (12): *Yeah, I was checking to see if it was done.*

Interviewer: *And how do you know if it's done or not?*

Participant (12): *So, I just look at it and if it looks puffed up, then I normally try to place it in my hand and see that if it's soft enough, or if it still feels hard then I cook it for a while more, so that was a decision at that point on whether the rice is cooked, or does it need to be cooked more and the decision was based on how it looked and felt like and at that point I decided that it's still not soft enough, so it needed to be cooked a bit more.*

Interviewer: *That makes perfect sense, yeah! What did you want from the cabinet here {00:25:20}?*

Participant (12): *I was trying to get the strainer out so that I could wash the vegetables and take out the rice.*

Interviewer: *Do you always wash the vegetables before using them, or was that something you experienced as having to decide over?*

Participant (12): *No, that's something I always do. {00:25:40} I also wanted a sponge [from the cabinet] to wipe the counter and that was a decision I made at that point, because I had thrown out the sponge I was using the previous day, so I needed a new one.*

Interviewer: *How come you decided to wipe the counter?*

Participant (12): *Because when I washed the dishes there was a little water which had come on the counter as well, so I was drying the surface. Also because while I cook, I try to keep the kitchen as clean as I can, because I share the kitchen with two other flatmates. Also because even at home if anything spills, I would try to clean it immediately and not leave it on the counter if something was spilled or anything.*

Interviewer: *Do you experience cleaning the counter immediately if anything spills on it something like a habit of yours?*

Participant (12): *Yeah, it's definitely a habit at this point.*

Interviewer: *Okay, interesting! Alright, so by now {00:26:48}, it seems like you're satisfied with the how cooked the rice is, and did you experience it as a decision that the rice was cooked and you were ready for the next step?*

Participant (12): *Yeah, that was for sure a decision.*

Interviewer: *Okay, so do you always the same oil you use to fry the rice here {00:27:29}, or was that something you decided to go for at that point?*

Participant (12): *No, I used to use vegetable oil in my cooking earlier, but then I switched to olive oil. So, when I was switching, I experienced it as a decision to start using olive oil from then on, but now I just use olive oil for pretty much all my cooking, so it's not a decision anymore.*

Interviewer: *Okay, I see. How do you how much oil you would need? I'm asking because you don't measure it and you don't use a spoon or anything, you're just looking at how much you can actually see there in the pan.*

Participant (12): *Yeah, it's just an estimate of how much I would need based on previous experience, cuz I mean, I'm learned cooking from my mom and she also goes by like, an estimated amount. So, I think just looking at it [the amount of oil in the pan], I can pretty much figure out how much I would need. It's also based on previous experience as well, because like I said, I made that dish before, but even the first time I made it, it was an estimate of how much oil I would need and not an exact measurement.*

Interviewer: *Yeah, I see. Okay, so what happens here {00:28:43} is that you're ready for the vegetables to go in, but then you look at the vegetables and suddenly shift to something else.*

Participant (12): *Yeah, because I looked at them [vegetables] and remembered that I haven't washed them and that's when I remember that I still have to wash them before I cook them.*

Interviewer: *Was washing the vegetables after remembering that you haven't washed them yet something you experienced as making a decision?*

Participant (12): Yeah.

Interviewer: *Okay, so here {00:29:13} the vegetables are all washed and frying in the pan and you go in your room. Do you remember why you went in your room there?*

Participant (12): *So, because the vegetables were already cooking and I just had to wait, I was trying to think of anything I could do in the meantime, but yeah, I came back in my room to see what there is to do and I check if there is water [in the room] and also to get my phone.*

Interviewer: *Yeah, you check your phone here {00:29:43} and take it with you back to the kitchen. I'm wondering if you had already decided to get your phone and perhaps that's why you went into your room, or did you just take the phone with you back to the kitchen because you just saw it there in your room and got reminded of it somehow?*

Participant (12): *I definitely got my phone because it just came into my visual field when I went to my room, because the goal of going to the room was just to check if there was water, if I needed to fill the water before I sat down for dinner, but then because I saw my phone there, I just end up getting it.*

Interviewer: *Mm hmm, yeah. Was grabbing your phone as soon as you saw it there something you experienced as a decision?*

Participant (12): *Yeah, that was a decision. Getting the phone was a decision, but before that, going into my room to check the water was also something I experienced as making a decision.*

Interviewer: *Oh, right. Thanks for that! Perfect! Okay, so here {00:30:43}, interestingly, what you do is that you see that you have a few notifications, but you don't open them. How come you decided not to open the messages you were notified of?*

Participant (12): *Yeah, because I have this thing where I only reply to notifications if I feel like that's something urgent or it needs to be responded to right away. I just only take the time to respond to all the notifications all together, because I think that saves a lot more energy than constantly opening social media to just reply to one person or message.*

Interviewer: *For sure, yeah. You put your phone aside here {00:31:12}. Was this something you experienced as a decision?*

Participant (12): *Yeah, that was definitely a decision I made that none of the notifications were urgent enough that I had to respond right away, so I could keep it for a later time and this was a decision I made at that point, so I put my phone away.*

Interviewer: *Right, right. So, here {00:31:37}, before you take the water into your room, you stir the vegetables on the stove. I'm wondering how come you did that? What urged you in stirring the vegetables at that point?*

Participant (12): *So, I can hear that it's making like, a sizzling sound, so I checked up on them to make sure that they're not burning or anything and I saw that they were cooking, so they just needed a stir to make sure that all the sides are being equally cooked. Again, this was a decision I made to give them a stir and leave them to cook.*

Interviewer: *Mm hmm, I see. So, here {00:32:12}, how did you know that it's time for the rice to go inside the pan with the vegetables, and was this a decision?*

Participant (12): *I put the rice in because when I was stirring the vegetables, I could feel that they had gotten a little bit softer, and yeah it was a decision because with cooking, or pretty much everything else, I knew the steps of the recipe and how the recipe goes and what steps to take to reach that final dish, but when to move from one step to the other is definitely a decision based on my experience with each step and the feedback I get. So, for example, I knew that I had to put the rice in once the vegetables were done, but deciding exactly when the vegetables were done was a decision based on experience and feedback like, how soft or brown they are, so it was up to me to decide when the vegetables were done.*

Interviewer: *That's really really interesting! Thanks for explaining this! So, what do you go for here {00:32:56}?*

Participant (12): *Just a spice mix to add to the food and it's part of the recipe, so it had to go in the food.*

Interviewer: *Okay, okay. So, here {00:33:30}, it seems like your meal is prepared and all cooked up, but you stand there for a few minutes and it seems like you're waiting for something, I think? Do you remember what's going on there?*

Participant (12): *So, after I add the spice, I'm supposed to cook it for another minute or so, so I'm just waiting for it [the food] to be ready.*

Interviewer: *And you suddenly got reminded of your phone here {00:33:44}? I'm asking because you take your phone and check it.*

Participant (12): *I had a notification when I was stirring the rice, so I was just checking again, checking if it was something I need to respond to right away.*

Interviewer: *Right. So, about the amount of rice you cook, how do you know how much rice would be enough? Do you measure it with like, the little cups they usually come with, or is it again, just by looking how much rice you're putting in the pan and just trying to go with a rough estimate?*

Participant (12): *No, for rice I definitely use a cup measurement, just because I don't like over cooking [cooking too much], so for rice I have a cup I use for measurement.*

Interviewer: *Fantastic! So, here {00:35:10}, what's the general goal?*

Participant (12): *The goal is to wash the dishes, and you can also see that I started with the plate which I explained earlier on about the structure I have for washing the dishes and that's exactly what you can see me doing there {00:35:20}, because I put them for drying, I have a particular order in which I arrange it [the dishes], so I try to wash it in the same model.*

Interviewer: *Cool! Is there a particular reason for this specific structure which you have developed, or was it something that just came organically?*

Participant (12): *So, I try to keep the plate against the wall so that it dries faster, cuz keeping in straight wouldn't help it to dry, and I keep the cups at the back so that if anyone touches the stuff in front, they wouldn't fall or break. So, I think it was just a very intuitive logic. So, the first time I developed this structure of arranging the dishes and washing them was like, a decision I made, but it's just a habit at this point. So, the final steps of washing the dishes as a goal is to empty the sink there {00:36:48} and wipe the counter for anything that has spilled, like water or something.*

Interviewer: *Mm hmm, yeah. So, what's going on here {00:37:07} then?*

Participant (12): *Here again I was also cooking lunch, so I was washing the dishes first and then lunch.*

Interviewer: *How come you decided to wash the dishes first, before moving on to preparing lunch?*

Participant (12): *Because I don't like to cook if the kitchen is messy. So, cleaning is always the first step to anything. Like I said, even when I wake up, like I need to clean first before I start my day.*

Interviewer: *And here {00:37:34}, you notice that the spoon is not clean?*

Participant (12): *Yeah, there was just something sticking to the spoon which I just saw it at that point, so I was just removing that before I could actually use it.*

Interviewer: *So, then {00:37:51} you wash the spoon. Was this something you experienced as making a decision based on the thing you saw stuck to the spoon?*

Participant (12): *Yeah, because I tried to remove it with my hand, but it was just sticking to the spoon, so I had to wash it properly remove it.*

Interviewer: *Okay, and you already know what you want to have for lunch there {00:38:02}?*

Participant (12): I do.

Interviewer: *Was choosing what to have for lunch something you experienced as a decision?*

Participant (12): *Yeah, it was a decision, because like I said, the decision on what to have to eat is based on like, how hungry I am, what ingredients do I have, what do I feel like eating, how much time I have, so every time I decide what to have to eat is based on the same factors and so, I experience it as making a decision to choose what to have in the end. One additional decision was whether I know how to make it [the decided meal]. So, the recipe that I'd decided to make that day was something I've never made before, but I really wanted to eat it, so then I had called my mom up before making it and O asked her how to make it, so she had explained me the recipe and the instructions. So, yeah, again that was an additional decision*

I made that I want to eat this, but I don't know how to make it, so my solution to this was to call up my mom and ask her for instructions.

Interviewer: *Oh, wow! Cool! So, I'm wondering if you hadn't made that particular dish before, how did you know of the dish at all? Had you tried it before?*

Participant (12): *Yeah, so I mean, at home whenever my mom used to cook it [the particular dish], I would be around the kitchen even if I didn't cook necessarily, so I knew pretty much what are the main ingredients I would need, so I knew that I had those [the required ingredients], so then I asked my mom "These are the ingredients that I have. Do you think I can make this?", because I didn't have a couple of the ingredients which will not be very important for the outcome of the recipe, so then I decided to skip those [missing ingredients] and just make it with the ingredients I did have.*

Interviewer: *Okay, and when you're putting the flour in the pan, you use a tablespoon as some sort of a measurement maybe? Are you counting to a certain number of tablespoons of flour which you need for the recipe, which your mom had told you about?*

Participant (12): *Yeah, she did, because since didn't make it [the recipe] before, so I had to ask how much flour I need to make it only for one person, so she told me the measurements and I just apply what she had told me. So, this time it's like, I'm cooking from a set of instructions that my mom had given me, so I try to be more careful about each step because I want to stick to her instructions and measurements as best as I can, because I don't have experience preparing that recipe before.*

Interviewer: *Oh, yeah, for sure. So, what are you looking for here {00:40:52} in the fridge?*

Participant (12): *So, I had to get out a couple more ingredients from the fridge, but then that's when I noticed that there was some water which was spilled in the fridge and then, I decided to remove everything there [inside the fridge] so that the things in the fridge don't get spoiled.*

Interviewer: *And you experienced removing everything from the fridge and cleaning everything before you put them back as decisions you made?*

Participant (12): *Yeah, those were decisions.*

Interviewer: *Okay, perfect! So, you mentioned already that you're cooking this meal based on a set of instructions which you've received from your mother, and I'm wondering if you still experience going through each step as a decision, or since you're just acting on the instructions received from your mom, you don't really feel like you're making any decisions in the process?*

Participant (12): *This was the first time I was cooking that recipe. I don't think I was making any decisions by myself for the cooking process, like if it was something*

I had already made before, for example, fried rice which I was making in the previous video, then for that recipe I could make certain decisions during the process because I knew how to make it, but for this recipe since I didn't know how to make it, I was just sticking to the instructions my mom had given and so, I didn't really experience making any decisions, it was just trying to stick to the instructions as close as I could.

Interviewer: *Interesting! Yeah, I totally get how you mean. So, here {00:42:15}, did you experience it as a decision to wash the fridge dividers?*

Participant (12): *Yeah, because I've seen that they were still a little bit dirty after I wiped it, so I decided to wash the up as well.*

Interviewer: *Alright, fantastic! So, in this one {00:42:58}, do you remember what's going on and what are you up to?*

Participant (12): *So, I was sitting down to work and I'd just made some tea for myself. This was in the night and I was a little stressed, so I made some tea and I was lighting my favourite candle just so I can sit down and work.*

Interviewer: *And did you experience it as a decision to make some tea and light a candle?*

Participant (12): *Yeah, definitely, because I don't light a candle every day, but I do it every now and then, but I think that day seemed like a nice day to light up a candle, so I just decided to do it.*

Interviewer: *Okay, and here {00:43:49}, you're filling your water bottle and what's interesting is that after you're done with filling the water bottle, you also water the plants immediately after that. I'm wondering how come you got reminded of the plants at that point?*

Participant (12): *Because I try to water my plants every morning, but that morning I was out, so I would have missed watering it and then, when I was having water, I remembered that I had to water the plants as well.*

Interviewer: *And did you experience watering the plants after you got reminded of them as a decision?*

Participant (12): *At that moment, yeah it was a decision.*

Interviewer: *How about to drink water at that point {00:44:29}? Was this something you experienced as a decision?*

Participant (12): *I mean, I was thirsty and I did think about it, but just because I was thirsty, I knew I had to drink some water, so I'm not sure if that was a decision I made.*

Interviewer: *Yeah, for sure. Okay, so here {00:44:54}, you're working and I'm wondering how do you go about arranging your tasks when you want to work? I* *mean like, how do you know what task to begin with and how do you generally, structure and plan your tasks and projects?*

Participant (12): *So, every morning I have a mental checklist of all the things I have to complete that day and I try my best to tick them all off from the list. So, what tasks I put on the list and how I prioritise them would first of all depend on the urgency, like what needs to be done urgently, so that would automatically be the first on the list of the things I have to do, but it also depends on how I'm feeling, am I tired or not, do I want to do something which is lighter work, or do I think that I can do something which needs more effort, and it also depends on what time am I sitting down to work, so based on how much duration I would have to work I would decide on the work. So like, even if I have like, three things in the mental list that I have to do, but I know that I'll only be able to sit for an hour and work because I would have to do something else after that, so I try to pick something from the three things which I know that I can finish. So, even if I had already planned things I need to do, I still need to take a decision which one to go for at each time based on the time I have and everything else.*

Interviewer: *Okay, that makes perfect sense, yeah. So, here {00:46:12}, you keep checking your phone and replying to the messages that you're receiving and based on what you've explained earlier, I'm assuming the messages were quite important and you decided to respond to them?*

Participant (12): *Yeah, my phone screen lit up which is why I took my phone there, because I think with my friend, we were planning on going to the National History Museum the next day, so we were planning and booking tickets and because our communication was happening and so, I stopped working and I started doing that work [booking tickets, replying messages and planning collectively with friend in chat]. So, yeah it was a decision to stop working and reply to the messages and book the tickets first and because the messages were about the plan for next day, I decided to respond to them because like, the communication was happening there. So, the goal was to book the tickets for the next day.*

Interviewer: *Right, and you decide to put on some music here {00:47:46}?*

Participant (12): *Yeah, because I finally finished booking the ticket, so then I decided and it was a decision I took to play music, cuz I play music if I don't need to read something, and since I wasn't reading anything, I decided to play music.*

Interviewer: *And how did you choose what type of music to play?*

Participant (12): *Depending on my mood, like, if I'm reading something, I try to listen to just instrumental music, but if I'm not reading something and if I'm in a mood for maybe a happy song, then I'll play a happy song, but if the mood itself is a very chill and calm mood, then I'll listen to a slow song. So, it's mostly depending on the mood I guess.*

Interviewer: *And is choosing what type of music, or what track in particular, to play based on your mood and what you're doing, something you experience as a decision?*

Participant (12): *Yeah, it is, because even though I have certain playlists, but deciding which playlist I want to play at that moment and what song from the playlist I want to listen to is something I experience as a decision.*

Interviewer: *Interesting! In this one {00:49:19}, have you already decided to read a book, or was it something you just decided on the spot?*

Participant (12): *Deciding that I wanted to read at that point was a decision I made, but I didn't decide on what book to read, because I was reading that book for a while, so I just continued reading that.*

Interviewer: *Perfect! How do you decide when to stop reading?*

Participant (12): *So, I was reading several short stories, so I think the decision that I made there was how many short stories do I want to read, because initially I thought I'd read two, but then I really liked reading it, so I ended up reading an extra short story, so I think that's when I made the decision of how many short stories I wanted to read.*

Interviewer: *Interesting! In this one {00:50:37}, you're doing some grocery shopping and I'm wondering if you already know what you want to buy and you just directly for that without having to look at other things, or is it like, you browse the shop and decide what to buy and what are your options basically?*

Participant (12): *So, whenever I go grocery shopping, I make a list of things which I need and I do browse the aisles as well, cuz sometimes when you're making a list, you might not remember that you wanted a certain thing, but then you look at it and then you remember that's what you wanted. So, it's both making a list and also browsing for something which I have might forgotten when making the list, like I already know what I want to buy, but I also browse just to see if I've missed anything.*

Interviewer: *And what are you looking at here {00:51:17}? What's going on in your mind?*

Participant (12): *I was looking at the Mexican section, because I was looking for salsa. I had nachos at home and I wanted to make baked nachos, so I was looking for salsa for that, but I didn't end up finding a salsa which I liked, so I didn't buy it. So, I needed it for a meal I had in my mind and I wanted to make, which was baked salsa, but apart from that it's just general grocery shopping, like I had to get a couple of things which I know I always require in my daily cooking based on experience, and not specifically for that dish [baked nachos].*

Interviewer: *So here {00:52:39}, how come you made an interesting decision to start drawing?*

Participant (12): *So, there are just like, these few things which I like doing. So, I draw like, not every day, but more regularly than for example, reading a book, because reading a book is not something I do every day unless I started reading a particular book and I want to finish it, but like, I try to read, draw, write, so even in the previous video during which me and my friend were trying to make a plan, I'd opened my laptop and I was trying to write something, but because I kept getting interrupted with the messages and the booking process, the flow was not happening, so I then decided not to write.*

Interviewer: *And may I ask what are you doing here {00:53:27}?*

Participant (12): *Oh, so, I have a list of places I want to visit and I had visited the National History Museum, so I was just ticking that off the list, because when I opened my bag to get out my pencil case, I saw the [note]book [inside the bag] and then I'm like "Okay, I'm just going to take the National History Museum off that [the list] before I start drawing".*

Interviewer: *Cool! You also decide to put some music on here {00:54:57}?*

Participant (12): *No, I'm choosing what I wanted to draw from.*

Interviewer: *Oh, okay, so you pick something from the internet and start drawing it. How do you decide what to draw from, like, what image to pick?*

Participant (12): *I just look at it and I see what I'm in the mood for, so I'm drawing a portrait of Harry Styles for one of my friends because she really likes him, so I just figured I'd just give that a shot.*

Interviewer: *That's super cool! So, you bring up the image you want to draw on your laptop, and then you look at it and try to copy it on the paper and every now and then you take a look at the image?*

Participant (12): *Yeah, because I try to copy how it is exactly, but I also do try to change a couple of things based on whether I feel like I can do it slightly better that the image itself, or if I feel like it's done really well and I can't [make it any better], so then, I just try to copy it manually, but those are just minor decisions I make on the spot, but otherwise, it's just more about just looking at the picture and trying to draw the same thing.*

Interviewer: *That's really interesting! So, every now and then you erase something from your drawing and redo it.*

Participant (12): *Yeah, if it doesn't turn out as well, so I just erase that part and redraw that. So, I'm constantly trying to compare it with the [model] picture and also because sometimes when you look at it, for example, you think that it doesn't match the proportion that you're drawing, so it's also looking at the image itself that I'm drawing and thinking if it feels okay, or does it not and also, comparing it* *to the original photo which I'm drawing from. {00:58:31} You see a lot of erasing because I was trying to draw the left hand and it was just not going good.*

Interviewer: *That's fascinating! So, do you always draw with just a pencil?*

Participant (12): *Yeah, I mean I draw with a pencil first and then decide if I want to outline it or leave it as a pencil, because this is one drawing of the theatre, I mean with the two masks, I decided that it looks better without outlining it with a pen, so I just left it as a pencil drawing, but all the other drawings I go forward and draw an outline.*

Interviewer: *Okay, so you suddenly went for your phone there {00:58:38}, and I'm wondering how come you checked your phone?*

Participant (12): *Because I heard the notification and saw that she had sent me a message, so I had to reply to them and that was a decision I made to reply to her messages.*

Interviewer: *Interestingly, you also add some minor details to your drawing.*

Participant (12): *Yeah, like I said, I try to add a couple of minor additions if I feel like that goes well with the picture, like, I just look at the drawing and all these minor additions I can only do once I feel like the drawing has started taking shape, and then I see how I can make it slightly better and then I decide if I want to make some additions to it, but when I'm doing the initial drawing, until I've done the major outline, I try to stick to the original picture as much as I can.*

Interviewer: *And do you experience these minor additions to the original picture as decisions you make?*

Participant (12): *I think it's more natural, because it just feels like naturally it would look better for the picture, because I've been doing this [drawing] for quite a few years now, so at this point it doesn't feel like a decision per se. It's also a little bit because of my experience with drawing as well, even though I haven't drawn that particular picture before, but because I've just been enjoying the process, it just felt natural, like for example, when I was drawing the left hand, it had a pose, but I realised that it was not going to fit on the page, but I still tried to make certain adjustments to see if I could still fit the pose in my drawing, but I tried and after a few times when it wasn't happening and it didn't look natural, I then made the decision that I should leave the hand pose out. So, yeah, there was a lot of decision making involved.*

Interviewer: *Fantastic! What are you doing here {01:01:21}? What are you thinking?*

Participant (12): *So, I finished the picture and then I outlined it with a black pen, and here I'm just holding it close to the laptop and comparing it to original picture and seeing if they're close enough.*

Interviewer: *And it seems like you feel like something still needs to be done with your drawing?*

Participant (12): *Yeah, I was just not satisfied with the left hand of the picture [drawing], like when I put them [the original picture and the drawing] next to the each other, I'm like "No, this [drawing] still needs a little more work" and that's exactly when I decided to leave out the hand pose, because I was not satisfied with how it looked. {01:02:10} So, I needed a book so that I have a little more support when I'm trying to draw.*

Interviewer: *Did you experience using the book for more support for your drawing as a decision?*

Participant (12): *Yeah, that was a decision, because the first couple of times when I outlined it, I saw that it would leave an impression on the next page, so then I made a decision that I'm going to keep another book under the drawing book so that it won't leave an impression on the drawing book.*

Interviewer: *Right, right, and every now and then you take a look at your phone.*

Participant (12): *Because I'm having a conversation with my friend and she wanted me to come out and see her, but we were deciding on the plan, so I was replying to the messages whenever she sent me a message, but that's the thing, like whenever I took my phone I only reply to her message and no other notifications.*

Interviewer: *Okay, but here {01:03:11}, you saw her message and you didn't reply and you went back to your drawing.*

Participant (12): *It wasn't her message, it was someone else's message, so then I was like "Okay, that can wait. I'm going to finish my drawing in the meantime".*

Interviewer: *Okay, and was not replying to that message something you experienced as a decision?*

Participant (12): *Yeah, because when I do these things, I just avoid any other distractions, like for example, in the reading video you could see that I do not touch my phone at all during the entire process of reading. Similarly, when I'm drawing, if it wasn't for the fact that I had to meet her right after, then I would not have replied to her message either, like I would just focus on finishing my drawing first.*

Interviewer: *Alright. Well, that's all from me. Thank you very much indeed. I'm going to stop recording now.*

PARTICIPANT NUMBER: 10

PARTICIPANT INFORMATION: Female, 22

DURATION: 00:39:55

DATE & TIME: 2021-06-19 | 20:25:56

Interviewer: *I've started recording now. Okay, thanks very much for your time! Right, so, let's dive in. What's going on here {00:01:11}? Do you remember?*

Participant (10): *So, I want to wash the dishes basically and here {00:01:14}, because I was watching a video the previous night and it was a discussion between two feminists and usually when I wash the dishes, I listen to something to kind of, make use of that time as well, so I put that here, so I could listen to it while I was washing the dishes.*

Interviewer: *Okay and here {00:01:34}, you're bringing the laptop closer to the sink so that you can hear the video while you're washing the dishes?*

Participant (10): *Yeah, yeah, because when you're washing the dishes, the boiler is right next to me, so I can't hear it [the video] unless it's very close and the volume of the laptop can't go higher than a certain amount and I think further on, I bring it even close than that and I clear the counter up [in the kitchen] to bring it closer so I can't hear it.*

Interviewer: *Okay and did you experience bringing the laptop closer so you can hear the sound of the video as a decision and something you decided over?*

Participant (10): *I think the first that I was doing it [bringing the laptop closer to hear the sound] I was like, figuring out the logistics of it, like, where should I put [it], because I used to actually listen to something on my phone before, um, so, yeah but, like, the first time was a decision but then from there it's more like a habit of how you manage to wash the dishes basically. Yeah, now I'm clearing the space {00:02:43} so that when I wash the dishes I can [listen to the video on the laptop].*

Interviewer: *I see. Alright. So, you put the cutting board in the above cabinet and I'm wondering if choosing where to put it was something you experienced as a decision, or is it more like, everything has its designated place around the kitchen so you don't need to think twice about where the board goes and you just put it there without having to really decide about it?*

Participant (10): *Yeah, that's exactly it, everything has its designated spot and I don't necessarily have to decide where to put things when I'm clearing out the kitchen and so {00:03:10}, I took the white thing [board] out as well, so I'm just rearranging the cabinet based on what's supposed to be where basically, so yeah, because it's got its designated space and I don't have to make any decisions.*

Interviewer: *Okay, yeah, I see. So, how come you decided to wash the dishes at that specific moment. Was this pre-decided, or you just decided like, spontaneously?*

Participant (10): *Well…so, it was my turn to wash the dishes but I don't think we have a lot of clean dishes left in the house at this particular point [both laugh]. So, if I didn't wash the dishes, I don't think we had a lot of like, any like, small dishes for breakfast. I mean, I think we have cups as you saw, but yeah, we didn't have a lot of clean dishes left at that point and it was my turn. So, here {00:04:19}, I'm trying to kind of, arrange the spoons and stuff in a way that they would be, you know, parallel to each other and kind of, yeah, so that everything has its place and when I want a spoon and I open the drawer…so everything has its designated place, I'm just making it cleaner because of my OCD basically, [both laugh] because we don't have these things in the kitchen where you have like, a separate space for spoons and forks and we kind of have to arrange it ourselves, so I do it every time, especially because my mum, whenever she comes, she ruins it, so yeah…*

Interviewer: *That's totally relatable! So, is it like, you have this mental image of how you want the forks and spoons to look like in the drawer, how tidied up you want them to be, and then you try to reach that state from which you kind of have some sort of an image in your mind?*

Participant (10): *Yeah, exactly. Yeah, so because I want things to be clean and organised, even if you're not necessarily seeing them, like, you don't have visuals on them, you know, and even with my room it's the exact same. So, whenever you're opening my drawers, everything is organised and I like to know that everything is organised in my drawers, or the kitchen and cabinets.*

Interviewer: *Okay, right. So, here {00:05:33}, do you remember what's the general goal you're following?*

Participant (10): *Yeah, so, basically the goal was cleaning this spot, so I could put the towel on it so the towel wouldn't get dirty underneath. So, the goal was still to wash the dishes and leave them on the towel to dry basically.*

Interviewer: *I see and how do you know how clean you want the table to be? As in, how do you when to stop cleaning the counter and so like, how clean is clean enough for you? How do you decide to stop cleaning at that point {00:05:53}?*

Participant (10): *Um, I think usually it's like, if I don't see anything like, any dirt and stains left on the table…because that is a wipe that you use for Covid stuff as well, so it's like alcohol and stuff like that. So, yeah, usually, when I use that I'm just fine and I feel like something is clean, but the other thing is like, if there are small, like, small bits of bread or like, crumbs or anything like that on the ground or on the kitchen table or whatever, also they [small bits of food and crumbs] shouldn't be visible for it to seems clean to me. Also, we right now have a[n] ant* *problem, so like, yeah, I just made sure that the surface is clean enough and there are no ants on them [surfaces] as well.*

Interviewer: *Perfect! So, it's as if you get some visual feedback from the table to see if you can see crumbs or ants or anything of that sort of it and then you evaluate how clean it is based on this visual feedback you get from the surfaces?*

Participant (10): Exactly, yeah.

Interviewer: *So, here {00:07:05}, do you remember why you went back to the room?*

Participant (10): *Yeah, because I had brought my own food to uni the day before and I wanted to get that Tupperware because I wanted to clean all the dishes already so I wanted to make sure I'm washing everything that needs cleaning.*

Interviewer: *Did you just remember about the Tupperware in your bag?*

Participant (10): *Yeah, yeah, I just remembered that, because of the spoons. So, we have three of the small spoons and I realised that there were none in the drawer and the things that needed to be washed.*

Interviewer: *Interesting! So, you remembered from the three small spoons that you still have Tupperware left in your bag from the day before and so, did you it as a decision to go to your room and retrieve it from your bag so that you can wash it while washing all the other dirty dishes?*

Participant (10): *I think yeah, because I was thinking that if I don't wash it right now myself, then we're going to lack a spoon and I'm the one who uses the spoons because I make coffee and stuff, and then I don't know when the next time we're going to wash the dishes is gonna be, because we usually leave it [washing the dishes] until very late and I would have to wash it anyway, so better I do it now than later on…yeah, basically that was the thinking process which basically, made me decide to get the Tupperware from my bag and wash it.*

Interviewer: *That makes perfect sense! Alright, so here {00:08:27}, you move the laptop even closer so that you can hear the video better?*

Participant (10): *Yeah, I think the whole process of cleaning that space [the surface on the kitchen counters] was so I could bring the laptop closer. Yeah, here {00:08:41} I'm basically preparing my space, like I usually do, before I actually start washing the dishes. Yeah, and I like, arrange the dishes in a specific way as well, so like, I always put them in a way that when I wash them and I'm going to put them to away to dry, they would be ordered by height and then, I always…like, if there are things in my way, I wash those first and I have a system of what to wash first. So, I wash the spoons and forks and cutlery first and then I wash the small plates and the big plates and then I wash like, the cups and then everything else, but here {00:09:23}, I wash the plastic ones [Tupperware] first because they were already in the sink and they were blocking my way.*

Interviewer: *I see. Interesting! So, it seems like you have a pretty specific structure for how to wash up. I'm wondering if you experience washing the dishes through the structure you just explained as a decision, like, what to wash first and how to pursue the goal of washing the dishes basically, is this something you experience as having to decide upon?*

Participant (10): *I think, um, again, for the first few times I definitely experienced it as a decision. So, I realised through the first few times that, I don't know, if I wash the smaller plates and then the bigger plates and then they'll look when you're arranging it or stuff like that, like, it was like basically, I did it a few times and realised what's the best or the more efficient way of doing it and it was a process of like, trial and error before finding the most efficient way of doing it [washing the dishes and leaving them to dry]. So, yeah, now it's more of a habit, but it was definitely a decision through the first few times.*

Interviewer: *Okay, I see. So, right now {00:10:04}, as you're washing the dishes, you don't experience what to wash first as a decision?*

Participant (10): *No, not really, unless like, there are extra stuff there and I need to kind of, figure out what I want to do with them which I would then have to like, decide basically.*

Interviewer: *Yeah, for sure. Do you remember what's going on here {00:11:09}?*

Participant (10): *I was sending an email…yeah, I wanted to send out an email.*

Interviewer: *Okay, so you're working here {00:11:44}, and then you take your phone. Do you remember why you went for your phone?*

Participant (10): *Yeah, because I wanted to listen to my interview recordings and because on my phone I can put bookmarks on the voice notes, I use my phone rather than my laptop because I have them on my laptop as well, but yeah, I prefer to do it on my phone. Okay, I obviously check my messages as well! [both laugh]*

Interviewer: *Did you experience taking your phone here {00:12:13} as a decision?*

Participant (10): *I think taking my phone was just like, the thing to do, because this is the page I have for coding my data basically, so I was like "Okay, I need to start doing this right now", so I'm not sure if I could say this was a decision. What I did experience as a decision was to start coding and this was just part of the process which just came like, naturally basically.*

Interviewer: *Yeah, no, that makes perfect sense! What about checking your messages on WhatsApp then? Was that something you experienced as a decision after you picked up your phone to listen to the interview recordings?*

Participant (10): *I was waiting for my mum to respond to something and she hadn't and the fact that I saw that she hadn't responded, I made a decision to kind of, poke her and say, you know…I sent her the two eyes Emoji indicating that, you know, why haven't you responded yet, so yeah, I did experience that as a decision actually.*

Interviewer: *Okay, and you're playing something on your phone here {00:13:24}?*

Participant (10): *Yeah, I'm playing something. So, I had listened to it until a certain a minute and then I play it to listen to the rest of it basically.*

Interviewer: *Okay, I see. So, generally speaking, how do you go about deciding what task to do first when you start working? So, how do you prioritise your tasks and how do you decide which task to get on with after deciding to sit down and like, work?*

Participant (10): *Usually, the things that are relevant to others, so, for example for the research assistantship that I'm doing, if I have to send them something, or for a work project if I have to make a post, hand in something, whatever…the things that are related to other people, I try to prioritise those and then my own work, so like, the thesis or like, writing an essay or whatever, it usually comes next, unless if it's something that's like, constantly there and then I guess I allocate specific time for [it] usually.*

Interviewer: *Mm hmm, and so, right now {00:14:30}, you're listening to the interview recordings and you're coding at the same time?*

Participant (10): *Yes, I'm listening to interviews and because they're in Persian, I didn't want to have to transcribe all of it because it would have taken a lot of time, I'm listening to it instead. So, instead of typing the entire thing [transcript], I just write down that in this moment, she talks about this and that seems relevant and then I say [type] what could be the relevant code for it, and then I have an extra column in the Excel file which I type out the quote in. So, if I choose to use that in the final work [draft], I'll write down the entire quote basically.*

Interviewer: *And each time you experience doing all these micro tasks and writing them down in the Excel sheet as a decision?*

Participant (10): *No, just the first time. So, the thing is, I put off doing my transcription for a very long time, because I actually wanted to transcribe all of it, but then I was so late that I realised I couldn't transcribe the whole thing [interview] because I transcribed one and I saw how long it takes. So, basically, yeah and I'd already talked to somebody about it because they told me it's crazy that you did like, 30 interviews in the first place and then she said that instead of transcribing all of it, she told me that it's going to take a really long time, so you can't do it on your own and instead you can have a system where you just write quotes on Excel and then I just enhanced it a step further by instead of writing the quote, I just wrote the content that I thought was interesting because I remembered a lot of things that they [participants] were saying as well. So, yeah, basically I thought about it for a while and then when I saw that I can't realistically transcribe all of it [interviews] as well, I started doing this which is a system I thought of and had to like, decide for it the first few times but not anymore. So, here {00:16:41}, I just keep stopping it [interview audio files], bookmarking it and I'm continuing.*

Interviewer: *And your sister walks in here {00:17:01} and it seems like you're having a conversation together. Do you remember what was that about and what's going on basically?*

Participant (10): *I think we were writing the things we have to buy. Yeah, so, she wanted to go shopping and we were writing the list of the things that she has to buy basically and that's why I went to the fridge and got the paper.*

Interviewer: *So, how come you go the fridge here {00:17:34}? What was the goal?*

Participant (10): *So, we have the list of the things we want to buy and the foods that we have, you know, arranged to eat during the week. So, we buy things we need for those [meals] from before and online, and then just to save the amount of paper that we use basically, I usually put them [the piece of paper used as a list] up there [on the fridge] so we can keep using them until they're all filled. So, that's why I came and picked this paper from the fridge.*

Interviewer: *Okay, this is interesting. So, you have certain meals that you plan to have during the week. Do you decide on these together with your sister?*

Participant (10): *Yes, so, usually if we're both here [in London], every Monday the things we ordered would come and then we would sit at lunchtime and write things that we want to eat for the next week. So, we would start ordering for the next Monday. So, we would think "Okay, so we have seven days. What are the foods we wanna eat? And then what are the things we need to buy? And then, are there things we need to buy for breakfast, fruit, salad, everything?", and then we would write them down and I would order them for the next week. Nowadays we just do it two days before rather than a week before.*

Interviewer: *I see, and do you experience deciding what to eat for the week and what to buy for those pre-planned meals as decisions which you have to make?*

Participant (10): *Yeah, yeah, for sure, because we have to, I don't know, think about what are we going to have during the next week and if for example, our parents are coming over one day, or my sister is going out one day and will not be around, or if we have like, deadlines during which one of us won't be able to cook and based on all of these, we basically decide together on the foods we want to eat during the week, yeah.*

Interviewer: *So, here {00:19:16}, you want to decide what your sister should buy since she's decided to go shopping?*

Participant (10): *Yeah, so she wants to go and buy it [food and ingredients on the list] herself, because we already ordered for the beginning of the week and we've run out of some stuff and so, she's going to buy what we need herself and we're making a list of all the things she needs to buy.*

Interviewer: *And how do you decide what to write down on the list here {00:19:38}?*

Participant (10): *So, we were going to have guests over, so based on that, like we were thinking of what are the things that we needed for the meal that we had decided to prepare for the guests and then we were like, writing the things [ingredients] we needed for that [the meal]. Yeah, so, based on that, we were just thinking of what things we need that we don't already have and stuff like that.*

Interviewer: *This is really interesting! So, my understanding is that you first decide together what meal you want to prepare and then based on what ingredients you need to make that meal that you don't already have, you decide what to put on the list and buy. Is this right?*

Participant (10): *Yeah, but also, usually what we do is like, if we have ingredients leftover from the week before that we didn't anticipate, we kind of decide based on that what to make. So, here {00:20:14}, we have some courgettes left from before that we definitely know we need to make, like, I know we had something from the week before that I hadn't made and we needed to definitely make it and I basically told her [sister] to buy this [an ingredient] so we can make that food that we need to make as well. So, it works kind of, both ways, like, top down and bottom up, yeah.*

Interviewer: *And do you experience all these decisions on what to buy for what you want to make and what to make based on what you already have as decision?*

Participant (10): *Yeah, yeah, for sure! Yeah, because there is a lot of like, thinking and planning involved based on so many things that we need to anticipate basically.*

Interviewer: *Alright. So, here {00:21:03}, what's the goal for which you come to the fridge?*

Participant (10): *I wanted to check if we didn't have something in particular, or if we did have to then decide whether to write it on the list or not. So, I was checking to see what we have or don't have, yeah. So, I'm exactly just checking the things we have to see if I need to add anything to the list and make sure I'm not forgetting anything that we would need, and I did add something to the list {00:21:44}.*

Interviewer: *Do you experience writing down on the paper what to buy as a decision you make?*

Participant (10): *Yeah, sure. Yeah.*

Interviewer: *Okay, thanks for this! So, in this one {00:23:24}, do you remember what's going on and what you're doing and like, what's going on in your mind?*

Participant (10): *So, as you can see, I do a lot of cleaning! Yeah, so I was cleaning my desk because I wanted to study and I just wanted to come back to my own desk [to continue studying] and I was just clearing it up. So, the goal was to continue studying and so for that, I was clearing up my desktop [surface of the desk].*

Interviewer: *And each of these pens and pencils that you put back in your pencil case here {00:23:44}, do you experience it as making decision? I'm asking because* *you take each one and you put them back in the pencil case one by one and it seems like you're doing this quite carefully and you're paying attention to it.*

Participant (10): *No, I don't experience putting the pens and pencils back inside [the pencil case] as like, making a decision, but again, this is a decision that I have made previously and I just go by it, so I guess that's just like, part of the process of clearing up my desk and that was the decision basically. Yeah, but, so basically, I am a bit OCD and stuff like that. I like all my pens to be aligned in the fact that all of their heads are in one place and they're all the same way basically. So, the fact that I was picking them up one by one, I was just checking that they're all in the same direction in the pencil case. That's what I'm doing, but then, again this is something I decided on at some point before and I was just going along with I had already decided some time before and it's not that I constantly have to decide for it.*

Interviewer: *That's actually super interesting! So, what's going on here {00:25:08}? What are you up to?*

Participant (10): *Um, so, I come from my brother's house and we had a small kind of party for my dad there. So, I'm not sure exactly what I'm doing but I was very happy. So, he [brother] had bought a lot of groceries and he basically gave me some of them. So, he gave me the milk and I continue to drink the milk there {00:25:38} because we didn't have space for it [in the fridge] and also because he'd given us cake. I check the date here {00:25:44} to see when that's [the milk] going to expire and it was 'til that day, so that's why I drink it.*

Interviewer: *Okay, so you wanted to check the expiry date for the milk and then you checked it and then you were like "Okay, this is good to drink"?*

Participant (10): *Yeah, so basically, I didn't even know we had milk left. So, I just checked and because I didn't remember, I just checked 'til when is it okay to drink it by basically and then later, because my sister wanted to have the cake, I was like "I'm just going to drink it with the cake". So, because that day was the expiry date, I decided to drink it. {00:27:04} Yeah, my sister was making tea for herself and then I pour the milk and then I realised that it was a bit too much for that cup.*

Interviewer: *I see, okay. Did you experience having the milk at that point as a decision {00:27:21}?*

Participant (10): *Yeah, yeah, because would have normally had tea, but then I realised that it's late and I wanted to sleep soon and then, at the same time, the milk is going go bad [expired] by the next day, so let's just drink that [the milk].*

Interviewer: *So, here {00:28:18}, I'm wondering if you came in the hallway specifically for the book, or did you take the book from the ground because it came into your visual field? Because it seems like to saw it here and then you bent down to pick it up. Were you looking for it or something?*

Participant (10): *So, I don't think my plan for coming there was to pick up the book, because I've just come from my brother's house and then, I basically was cleaning the things out there and putting the milk back in the fridge so it doesn't go bad and putting away the groceries he [brother] had given me and then I came back there [in the hallway] and I saw that oh, I haven't still picked up the book to see it. So, that's why I picked it up, but I did it because I just saw it there so it wasn't something that I had decided on before basically.*

Interviewer: *Okay, and so here {00:29:25}, it seems like you and sister are going to have some cake. Did you experience it as a decision to have some cake?*

Participant (10): *Yeah so, she wanted to have cake and so I was like "I'm gonna have cake too".*

Interviewer: *Was having cake always part of the plan, or did you like, see your sister having and you just had like, a craving for it and decided to have some on the spot?*

Participant (10): *That [having cake] was not the plan, because the cake was intended for her. I was just like "If she's gonna have cake, I'm gonna have it because I may not have it later, or I might not be able to have it later on".*

Interviewer: *Smart move! [both laugh] So, here {00:30:19}, as you're having the cake, I'm wondering if each time you pick a piece and put it in your mouth and then you sip some milk, do you experience these as a decision, or is it like, something unconscious?*

Participant (10): *I think maybe the few like, you know, bites, to kind of get the right balance of the taste of the cake and the milk, and then after a while, much like most of the decisions we've talked about until now, it just becomes more automatic I think and then like, after a while the goal just becomes finishing it rather than savouring every bite, I guess.*

Interviewer: *So, I think here {00:31:46}, you're ready to call it a day and you're planning to sleep soon?*

Participant (10): *I think it was around 11:30 or something, so yes, it was quite late because I usually sleep like, before 12.*

Interviewer: *Okay, and here {00:32:09}, what you do is that you take your sister's plate to the kitchen as well, as you're taking yours.*

Participant (10): *Yeah, I just put them in one [pile] and took them [to the sink] so that they would be easier to wash later on, because we have the ant problem as well, so I kind of have to put water in it so the ants won't gather.*

Interviewer: *Okay, and did you experience this as a decision to take the plates to the sink and put them into one pile for later on and then pour water in them because of the ants?*

Participant (10): *Definitely! That is like, constant decisions for me which I experienced. I took those decisions very consciously.*

Interviewer: *It seems like you're also tidying up the kitchen a little bit here {00:32:48}.*

Participant (10): *So, my sister reminded me that we hadn't put the food from lunch back in the fridge, so I just put it and I drank the rest of the milk as well to finish it off and I put the new milk I had brought from my brother's house in the fridge as well and because I drank the previous milk, I just put the new one in its place instead of the previous one which I finished off and like, it was mission accomplished then, which is why I make the thumbs up there {00:32:12}. [both laugh]*

Interviewer: *And you do something quite interesting here {00:33:42}. After closing the fridge, you go back to it and it seems like you're double-checking for something.*

Participant (10): *I think it was like, the noise that the fridge made was not the noise it usually makes when it's closed properly. So, that's why I checked because it made like, a different sound that it usually makes basically.*

[Continued…]

APPENDIX E) EXPLORATORY STUDY

General Objectives

The exploratory phase of this research served as a crucial foundation for the main study and was conducted to achieve five objectives. After listing these objectives, we will describe what actually happened.

1. To gain a preliminary understanding of the subjective experience of MDM in everyday life:
    - By collecting SEBE data from a sample of participants engaging in their typical daily activities, the exploratory phase captured the real-time, situated experiences of DM as they unfold in natural contexts.
    - Through conducting RIWs with participants, we managed to explore the participants' subjective perspectives on their DM processes, uncovering insights into the cognitive, affective, and contextual factors that shape DM.
    - Through collecting open-ended descriptions directly from the participants, we collected detailed descriptions of various situations and activities in everyday life.
2. To identify key themes and patterns in everyday DM:
    - By employing TA to analyse the data collected during the exploratory phase, we aimed to identify recurrent themes and patterns in participants' experiences of DM.
    - This analysis helped uncover the common challenges, strategies, and influential factors that characterise everyday DM, providing a rich, data-driven foundation for the main study.
3. To identify representative activities for studying DM in everyday life:
    - By examining the range of activities captured in the SEBE data, the exploratory phase identified specific activities that are particularly relevant for understanding DM in real-world contexts.
    - Our initial exploration also helped us identify where to start investigating DM, considering the issue's large magnitude and scope. Thus, we began the main study with a focus on micro-decisions.

    - This objective involved pinpointing activities that involve frequent, diverse, and inconsequential micro-decisions, such as cleaning, cooking, commuting, rearranging, grocery shopping, etc., which served as focal points for the main study.
4. To refine the research design and sampling criteria for the main study:
    - Based on the insights gained from the exploratory phase, we refined the research design and sampling criteria several times to ensure that the main study is well-suited to capture the complexity and diversity of MDM in everyday life.
    - This further involved adjusting the SEBE protocol, modifying the RIW structure, and expanding the sampling criteria to include a more diverse range of participants and activities.
5. To inform the development of the RRIW protocol:
    - The exploratory phase provided valuable data and insights that informed our development of the RRIW protocol, a novel extension of the SEBE methodology that involves participants coding their own data.
    - It also provided us with an archive of open-ended descriptions of everyday DM, which served as a basis for developing visual cues and terminology for the RRIW protocol. By conducting textual analyses (frequency analysis, word clouds, etc.) of the verbatim, we developed the cards we used for the RRIW procedure in ways that were aligned with the participants' descriptions. In other words, the codes we developed for our identified behavioural variables were extracted directly from the verbatim.
    - By analysing participants' experiences and DM processes in the exploratory phase, we identified key decision points, behavioural markers, and subjective experiences that should be captured in the RRIW protocol.

By achieving these objectives, the exploratory phase laid the groundwork for a robust, data-driven main study grounded in participants' real-world experiences. The insights gained from this phase guided the refinement of the research design, sampling criteria, and analytical approach, ultimately contributing to a more comprehensive and ecologically valid understanding of MDM in everyday life.

Data Collection

The exploratory phase collected real-time evidence recorded through the subcams while utilising and testing the SEBE protocol to capture and investigate decisions in situ. Over 61 hours of ethnographic first-person perspective video recordings of typical days and following interviews were collected from a sample of young adults for the exploratory phase.

More specifically, a total of *44 hours, 3 minutes and 25 seconds* of SEBE recordings were collected for exploration purposes from a sample of N=16 who wore the subcam through their typical daily activities. *41.65%* of the total duration of SEBE recordings was from male participants, while *58.35%* was recorded from females. An average of *3 hours, 9 minutes and 49 seconds* of each participant's everyday life was recorded. Following the SEBE phase, RIWs were held with participants, each lasting for an average of *1 hour, 15 minutes and 8 seconds*. A total of *17 hours, 31 minutes and 52 seconds* of RIWs was conducted with N=14 participants. *42.83%* of the total duration of the RIWs was with male participants, while the remaining *57.17%* was with females. Upon obtaining the participants' consent to use RIW sessions for demonstration purposes, samples of RIWs can be viewed using the following links: https://shorturl.at/TDQCw, https://shorturl.at/D6LZS,

The subcam footage shows participants as they engage in various "typical" activities that they perceive as part of their everyday life. Recorded activities include cooking, cleaning, commuting, working, grocery shopping, reading, organising, doing daily administrative tasks using the mobile phone, doing laundry, drawing, and other daily activities. During the RIWs, the subjective experience of DM through the activity process was explored to gain detailed open-ended descriptions of the subjective experience of DM in everyday life. Participants explained and made explicit their thought process through various stages of an activity, including whether they experienced certain instances (e.g., when a shift in activity occurs) as making a decision:

> ***Interviewer:*** *And you put the bag in the drawer. Is that where the bags always go, or is like, something you had to think of and decide upon?*
>
> ***Participant (7):*** *Um, so that's where all the big ones [bags] go and that's why I put it there and I think I first want to just put it in and so, that wasn't a decision, it's just where the bags go, but then I saw the other bag in the drawer where all the bags go in, and I decided to put the bag inside the other bag with the other ones and that was a decision because as you can see I first put it somewhere else and then I'm like "Oh, wait, there's a bag" and then like, because it came into my field of vision I decided to put it [the bag] in [the other bag in which all the bags were]. So, I had forgotten that the bag [with all the bags in it] is in the drawer. It wasn't part of my knowledge anymore, like, it wasn't part of my memory anymore I would say, so I had to see it again to remember. {00:23:10} There I go to charge my phone was dying and I knew that we would leave so I wanted it to be charged, but then I*

discovered the other charging cable and I was like "Okay well, I don't need this one", so I decided to plug this [the first charging cable] back in and use the real [original] charging cable for my phone, and now {00:23:41}, I'm checking if it's actually charging and then {00:23:48} I'm sitting down to work.

Thematic Analysis

The RIW transcriptions were analysed using the TA method to develop a detailed descriptive account of how individuals experienced DM as they engaged in typical everyday activities. One of the main reasons for choosing TA was its flexibility, which provided the researcher with the opportunity to properly analyse the recorded data and identify themes that emerged as being important to the description of the experience (Attride-Sterling, 2001; Fereday & Muir-Cochrane, 2006).

The first step for an in-depth TA was coding the collected data. To this end, common concepts mentioned by the participants, as they were reconstructing the activities during the RIW, were identified to enable a basic analysis of the action control process and when and how the actor experiences making a decision (Morse & Field, 1995). Using an inductive approach (Boyatzis, 1998), the data itself was then analysed to determine the threads that integrate and anchor the codes and were identified as themes (Mayan, 2016).

Overall, 5 main themes emerged from the analysis of the RIWs, during which participants reconstructed the recorded daily activities and explained their subjective experience of the activity process, including DM:

1. Deciding over a future desired/required state (goal and/or motive)

"I have a mental image of how the final dish is supposed to look like" – P12

"I felt like having something savoury" – P2

"I was just feeling hungry at that time."- P6

"I knew I need to study in my room and if I just don't clean the room, then I will just be a bit unhappy and my desk needs to be clean and empty when I study" – P5

"The goal I'm following here is cleaning my room and making my room more like, clean and more aesthetically pleasing"- P4

2. **Installations** (regulation of activity)

"It needs to be a bowl so that I can put water in it" – P6

"We only have French press, so that's the go to coffee in this house" – P9

"I wasn't sure like, if we have something that you use to open the jar with"- P7

"That's how I always clean" – P12

"I wash my hands every time after I clean, so, it's mostly a habit by now that I'm so used to" – P1

"She [girlfriend] has made that dish before, so I kind of knew what I need to do because she was telling me" – P8

3. Evaluation and judgement

"I was done tidying up the room" – P12

"The Wi-Fi is not really working" – P8

"I ran out of mopping liquid" – P7

"I'm pretty sure I go back and forth as well until the overall situation is like "okay, this feels like it's clean enough" – P1

"I just want the room to be clean enough" – P3

4. Feedback acquisition (trial and error)

"I've poured oil into pots and pans enough to be able to roughly tell how much I need and how two teaspoons would look like" – P8

"I've been drawing for quite a few years now so at this point it doesn't feel like a decision per se" – P12

5. **Efficiency** (speed and energy)

"It's just the shortest way [to get to the tube station], and I just want to get to uni as soon as possible, so I just take the most straight forward and shortest route" – P4

I'm running around sweaty for like a very long time now, and I also realised, I could have showered but, you know, I might as well streamline the activities. So, it's like if I'm coming back home from a run anyway and I need to shower anyway, right? I'm going to clean everything, right?" – P3

These themes integrate the 13 identified codes during the TA of the data (see Appendix for the complete codebook and complete transcriptions of sample RIWs).

A Zoom on Cleaning Activity

Among all the recorded activities, *cleaning* was identified, in the preliminary data, as an ideal representation of a typical everyday activity through which various small decisions are made by the actor, although not all of them were explicitly experienced as such. While the purpose of our research is to investigate everyday MDM via a diverse set of methodologies, cleaning emerged as an ideal vehicle for an initial exploration, providing the research with the required data. Extracting certain moments from the data where the actor is constantly shifting between cleaning micro-tasks while trying to achieve certain goals and sub-goals had much to reveal about how, if at all, participants experience MDM and what type of typical everyday activities we should focus on through the main study.

While emphasising the necessity to consider and analyse decisions within their contexts, the practical activity undertaken by the subject in each condition and a particular situation is itself the context. Thus, we found it necessary to analyse the entire process of the activity, captured by the subcams and explained by the participants, in detail to identify and describe moments of decision. Upon identifying cleaning as an ideal representation of common everyday activities, we extracted all the scenes through which participants engage in tasks such as washing up, de-cluttering, tidying up, (un)loading washing machine/dishwasher, clearing surfaces, mopping, brooming, vacuuming, dusting, and wiping. By zooming in on the flow of actions and referring to the RIWs for the enveloping thought process, various components and activity building blocks were identified, described and coded. Table X is a sample of our initial coding process (see Appendix for more coding). Additionally, Table X is our complete codebook for the exploratory study coding.

Table E1

A sample of activity components and granularities coding for exploratory phase

Participant	Activity	Duration	Goal	Timestamp	Task	Location	Action	Reason(s) for action initiation	Operations	Mediators
10	Cleaning	00:16:50	Clean kitchen	00:00:08	Wear apron	Kitchen	Wearing apron	Reactive: Sensory cue	Wear apron	Apron
10	Cleaning	00:00:09	Prepare the kitchen for washing the dishes	00:00:09	Use laptop (YouTube)	Kitchen	Putting something on YouTube to listen to	Proactive: Affect, Reactive: Internal	Use laptop (YouTube)	Laptop, YouTube
10	Cleaning	00:00:27	Wearing apron	00:00:27	Put back cutting board into the kitchen cabinet	Kitchen	Decluttering	Reactive: Feedback: Internal, Reactive: Environmental cue: Interacting with similar objects	Put back cutting board into the kitchen cabinet, Straighten cabinet liner, Put back dishes in upper	Cabinets, Cabinet liner, Kitchen drawer

									cabinet, Put back cutlery in drawer	
10	Cleaning	00:01:08	Putting something on YouTube to listen to	00:01:08	Rearrange	Kitchen	Rearranging cutlery in kitchen drawer	Proactive: Completion	Rearrange	
10	Cleaning	00:00:30	Decluttering	00:00:30	Remove objects on surface	Kitchen	Freeing up surfaces	Reactive: Obstruction, Proactive: Completion	Remove objects on surface	Counter
10	Cleaning	00:00:28	Rearranging cutlery in kitchen drawer	00:00:28	Remove crumbs from surface	Kitchen	Cleaning the counter to place washed dishes	Reactive: Feedback: Internal, Proactive: Completion	Remove crumbs from surface, Wipe surface, Place towel on surface	Bin, Disinfectant wipe, Towel

10	Cleanin g	00:02:0 0	Freeing up surfaces	00:02:0 0	Remov e food remaind er from dishes	Kitchen	Gatherin g all dirty dishes in sink for washing	Proactive: Streamlini ng, Reactive: Environme ntal cue: Interacting with similar objects	Remove food remaind er from dishes, Gather dirty dishes in sink	Bin, Sink

Table E2

The complete codebook for the coding process of Exploratory Study

#	Code	Definition	Description/Criteria	Example	Theme
1	Mindset	Subject's psychological state	Related to subject		Activity components
			Emotions and feelings		
			Mood		
			Beliefs		
			Internal context of the activity		
2	Goal	Purpose of activity	Chosen by the subject		
		Objectified motive	Influenced by mindset and environment		
		Future desired state	Overshadows and scaffolds the entire activity process		
			Stimulates activity		

			Consciously set by the subject (not imposed)		
			Subject interprets the environment and the following emerging tasks and actions in light of it		
			Subject is able to explicitly verbalise the goal and offer various rationalisations for it		
			Future oriented		
			Subjective representation of a discrepancy between a current state and a future desired one		
			Involves thinking		
3	Task	Concrete objectives that will gradually lead to achieving the chosen goal	A breakdown of a goal into concrete objectives		
		Subject's "action plan" to reach a goal	Influenced by the environment and subject's embodied competences and previous experiences		

			Consciously set by the subject in light of a goal		
			Involves thinking		
			Subject is able to explicitly verbalise the task(s) and offer various rationalisations for it		
			Changes with a change in location		
			Affected by individual differences		
			May change as a reaction to a change in conditions		
4	Action	Realisation of the tasks	May turn into operation after enough practice, repetition and experience (operationalisation)	Example 2	
			Requires minor thinking and more monitoring for moments of intervention, if needed		
			Subject can verbalise if asked about (rarely freely mentioned by the subject)		
			Heavily influenced by installations		

				Subject stays aware of the actions and can explain them in light of the task at hand		
				Occur with some degree of automaticity although the subject stays aware and monitors the situation		
1	Proactive		No apparent reason for action initiation/switch	Are not performed as a response to an external prompt		Reasons for action initiation/change
	1	Routine	A sequence of actions regularly followed	Referred to by the subject as "routine", "habit", etc.	Morning routines	
	2	Streamlining	Sequencing ecologically similar actions into a single chunk	Efficiency	"I might as well […]"	
				Building up physically and environmentally similar actions into one	"While I'm at it […]"	
				Save time and/or energy		
	3	Completion	Action complete: satisfactory judgement achieved	The subject perceives the action as done and is satisfied with the results.		

		4	Continuation	Unfinished action: satisfactory judgement not achieved	Going back to an action which was abandoned prematurely		
		5	Interruption	Action abandoned prematurely	Satisficing judgement achieved		
		6	Affect	To make a situation more pleasant and enjoyable	Includes preferences, personality, and traits		
		7	Waiting	Passively waiting	Subject is waiting for something	Waiting for food to cook	
	2	Reactive		Action initiated/switched as a reaction to prompts and stimuli	Reaction		
					Remembrance		
					Response		
		1	Sensory cue	Prompt/stimulus received through the senses	Subject remembers/reacts/respons to a sensory prompt/stimulus		
					Heard something		
					Saw something		
					Smelled something		

						Touched something		
						Tasted something		
		2	Environmental cue		Prompt/stimulus received from the environment	Something external prompts an action		
			1	Physical proximity	Being physically close to something	Being physically close to something		
			2	Location prompt	Being in a specific location	Entering and/or leaving a specific location prompts the subject		
			3	Interacting with similar objects	Handling similar objects	Handling (touching/operating with) similar objects		
		3	Feedback		Evaluation of the action result and/or the environment	Subject evaluates the situation/environment and/or monitors the action results		
			1	Internal	Feedback acquired from the actor	Sensory feedback		
						Testing results against affect/task/goal		
						Actor makes a judgement of the result of the action herself and reflects (reacts)		

			2	External	Feedback acquired from external sources (i.e., mediators)	See "Mediators"		
		4		Obstruction	Action is blocked by an obstruction	Action cannot be completed because of an obstruction of some sort		
		5		Social cue	Communication with others	Conversation		
5	Operation				Motor skills	Subject's motor skills	Example 1	Activity components
						Occur in a "channelled mode"		
						Subject is conscious but cannot explicitly verbalise or pinpoint them		
						May be brought into attention and turned into action		
						Does not require thinking		
6	Bodily movements				Motor movements	Unconscious		
						Minor motor movements		
						Seemingly meaningless		
						Subject not aware		

			Sometimes involuntary		
7	Mediators	Action and/or cognition is distributed to external sources	Artifacts/tools/objects/others/(digital) platforms/etc.		
1	Tools	Action distributed to objects	Subject relies on objects to complete an action		Distributed action
			Includes subject's motor skills to use and operate with an object		
			Action is distributed to an object while the subject remains as an evaluator		
			Monitoring is taking place		
			Depending on the operator's embodied competences, may be more or less automatic (operationalised)		
2	Others	Action distributed to others	Involves social interactions		
			Some type of social representation of the action (e.g., language) is used		
			Includes subject's social skills to communicate with others		

				Is regulated and supported by social norms		
	3	Digital platforms	Subject pursues a digital transformation (The use of new, fast and frequently changing technology to solve problems)	Social media platforms	Facebook, Twitter	
				Knowledge platforms	Quora, Yahoo!	
				Media sharing platforms	YouTube, Spotify	
				Service-oriented platforms	Uber	

Such coding structure enabled us to quantify and test some of our findings and ultimately provide the research with a framework to analyse MDM and identify areas of utmost significance and interest. It also informed our RIWs, ultimately providing us with an entry point to shed light on some obscured areas within decision research. Below are some extractions from the RIW verbatim which we used to reconstruct the activity processes and code our data:

“No, that was the plan, the plan was that I needed to clean the place because it's been rather dirty and I had some really intense times so, I couldn’t do the normal maintenance and stuff and then I also realized that this type of cleaning would make me feel dirty and so, it's like if I’m coming back home from a run anyway and I need to shower anyway,right? I'm going to clean everything, right? And then hop into the shower afterwards, right? And everything's shiny and neat, you know? And I’m happy. So, actually I’m running around sweaty for like a very long time now, and I also realized, I could have showered but, you know,that’s sort of the thought process, you know, I might as well streamline the activities.” – P1

“Okay, so when this room is clean, you know, or rather when I sweep the floor it’s going to be wet. So, what do I need from this room whenI’m in the other room, so that I can that and sort of…yeah. […] and then the overall goal here is to get the room into a state where I can broom it. So, part of that is fetching the broom, part of that is, you know, tidying up, part of that is beating the mats and getting rid of them. So, I guess the overall goal is to trying to get the room ready. Then, I’m actually not thinking very much as we’ve seen and some of the, you know, very bright blue denim on the chair caught my eye and I was like “well, this needs to go”, right? So, I get it out of the way.” – P9

Our initial attempt to identify the activity components and characterise them for coding purposes led us to identify 6 dynamic and ever-changing components: *mindsets* (participant’s psychological state, mood, feelings, emotions and beliefs which make up an activity’s internal context), *goals* (a future desired state which manifests as an objectified motive to represent the purpose of the activity), *tasks* (participant’s “action plan” which is essentially concrete steps to reach the chosen goal), *actions* (realisation of tasks), *operations* (participant’s motor skills which occur automatically and within a channelled mode), and *bodily movements* (seemingly meaningless motor movements which occur entirely unconsciously).

The below table summarises our data analysis for the exploratory study. Around 10 hours of everyday cleaning was extracted from about 50 hours of total SEBE recordings from 16 participants (see Table E3). On average, cleaning tasks comprised approximately 20% of the recorded everyday life. We interpret this as the consequence of the choice by our participants who were using the Subcam for the first time and probably felt uncomfortable using it in public places to do the recording at home, at times when they were not having social activities. Over 17 hours of RIWs were held with the participants. Regarding location, all cleaning recordings took place at home, with the kitchen being the most common. Following the extraction of cleaning instances, the recordings were coded based on the activity components and the reasons for the switch in actions (see Appendix for a complete codebook and samples of the coding process). RIWs are referred to understand the underlying thought process and the actor's goals and motives. For quantification purposes, and in addition to describing the activity components and focusing on moments of initiation/change, each component's total number and the average duration are noted. Such coding structure later guided us towards parts of an activity through which micro-decisions are more likely to be experienced explicitly by the actor.

Table E3

Summary of cleaning activity coding for the exploratory phase

Total # of participants		16
Avg. age		29
Gender distribution	Female	68.75%
	Male	31.25%
Total duration of SEBE (total duration of recorded everyday life)		49:55:10
Total duration of cleaning activity		9:49:08
Cleaning % from total SEBE		19.67%
Total # of cleaning extractions		55
Avg. duration of an extraction		0:10:43
Total duration of RIWs		17:31:52

Our preliminary investigation of the data suggested that micro-decisions in everyday life are mostly experienced with the emergence of an opportunity to change the environment in such ways that would solve a problem and/or improve the conditions by reducing the discrepancy between a future chosen state and the current one. Such decisions are more explicitly experienced by a thinking individual when the situation is unknown and involves uncertainty. Through time, learning, and experience, decisions gradually become actions which, in turn, operationalise and occur automatically and via a "channelled mode" through which there is awareness and some degree of control but little or no critical monitoring and reflection.

Participants can (and do) explain in detail the rationale of their decisions (see Appendix D1 for samples of the entire RIW transcriptions). They spontaneously do so. For example, P5 gave a detailed explanation of what brought him to decide to clean his room: *"I knew I need to study in my room, and if I just don't clean the room, then I will just be a bit unhappy and my desk needs to be clean and empty when I study"*. In a similar vein, P12 described her decision to buy a certain item from the grocery store *"I was looking at the Mexican section, because I was looking for salsa. I had nachos at home and I wanted to make baked nachos, so, I needed it for a meal I had in my mind and I wanted to make, which was baked salsa*".

The explanations provided, although they make perfect sense, are mostly of setting up a goal or a task (in the sense of Activity Theory) and then acting to change the situation and the environment until this goal is attained. While it seems to be influenced by the conditions given, such an objectified motive appears to be what initiates activity in the first place and for which participants describe explicit experiences of decision-making. At this level, it is clear that participants are actively thinking and have a general idea of what they want to do or what they hope to achieve/satisfy: *"I experience the cleaning part as a decision"* (P10), *"The decision is whether to clean [the room] or not"* (P12).

While the perplexing flux of everyday activities may seem confusing from the outside, such chains of actions are subjectively interpreted by the actor in light of the purpose or the objectified motive which they serve. It appears that what keeps a flow of numerous and various actions subjectively meaningful is the participants' goal(s), which integrates them and ultimately enables the participant to explain what (s)he generally hopes to achieve. To illustrate, P6 explained her constant shifting from one action to another while cleaning her room: *"The goal I'm following here is cleaning my room and making my room more clean and aesthetically pleasing"*. This differs from the lab situations where the subject is offered a choice between several available goals/tasks/actions.

Participants often mention that a *"decision"* did not follow the same process *"the first time*"; many mundane daily actions (such as cleaning a table or preparing breakfast) first occurred at problem-solving and were creatively solved the first time; but now applying the same solution and procedure has become a default option and does not require the same attention. This does not mean that the participants are unaware or do not experience that as a decision, but the action seems to be performed in a *"channelled mode"* as described by Lahlou (2017) and scaffolded by the installation (e.g. the kitchen). Through such mode, and while attempting to reduce a discrepancy between a current state and a future chosen one, participants *"go with the flow"* (P5) of their motor skills. This is very much in line with what Suchman (1987) describes as situated action, where the subject relies on her embodied skills to address the continuously changing challenge of the situation without following a specific plan in detail, but nevertheless keeping in mind the goal. These local *"operations"* (e.g. loading the dishwasher) are experienced as occurring naturally and automatically. Thus, our preliminary analyses suggested that the activity emerges from a need, an objectified motive, which the participant is conscious and aware of. A dynamic system of tasks, actions and operations then follows (see Appendix for a full description of each activity component in the codebook followed by examples). Participants seem to be aware of the tasks and the action course they take to fulfil their purpose: *"I'm trying to decide what to make [for dinner] and then what's the next step from there"* (P6). *"I have a mental image of how the final dish is supposed to look like, as well as knowing the steps and instructions I have to follow"* (P12).

On the action level, participants appear to be actively thinking, as P6 explains her thoughts on assigning a goal and choosing tasks as dynamic and purposeful course of actions: *"I'm trying to decide whether to clean and then what's the next step from there*". Through learning, time, and experience, some actions can and may gradually turn into operations, in which case they will require much less attention and very little, or none, active thinking from the participant. Operations are essentially an individual's automated embodied motor skills, which participants find hard, or strange, to verbalise and experience as occurrences that do not require much thinking and happen with some degree of automaticity. For example, P8 explained the operation of putting a meal inside the oven for it to cook as something *"that was just very obvious"* to her and was done rather *"automatically"* (P1, P6, P8). Such an operation followed her decision to have something to eat and the action of preparing a specific meal. Similarly, P9 explained how she did not need to *"really think"* about how much oil to pour into the pan, illustrating the operationalisation process: "*I've poured oil into pots and pans enough to be* *able to roughly tell how much I need"*. Moreover, P12 described making the bed immediately after waking up: *"I think it's more something that I always do as soon as I wake up and start my day. I just do it without thinking, so I don't experience it like making a decision to make my bed"*. Such examples illustrate how actions can become operations over time and by becoming skills, habits and routines and occur through a channelled mode.

Our initial attempt to code and quantify some of the findings suggested that a considerable proportion of everyday activities, such as cleaning, consists of operations through which no explicit experiences of DM occur. For example, 4 tasks, 21 actions, and 70 operations were counted in 18 minutes of typical everyday cleaning, giving this case a ratio of 77% (70/(21+70)) of the moves being operations that do not involve, from the perspective of the actor, a decision. As another illustration of the prevalence of operations in everyday activity, P1 described his typical house cleaning as a process that he developed at some point and has become how he *"always"* does it. Consequently, he *"can just turn off the brain because there is not much active thinking going on"* through the flow of habituated and automatic operations. He later explained that "*this time, the cleaning has become a bit more extreme because of the state of the room"*, illustrating the dynamic, flexible and ever-changing nature of the activity components in relation to one another, as well as the environment and the situation in general.

The data analysis further illustrated a dynamic relationship between the actor, his/her actions, and the environment through which actions and operations do not necessarily occur in a sequential manner (i.e., one following the completion of another); rather, an action course is constantly interrupted as P1 explained his cleaning activity as swiftly shifting from one task to another and going back and forth until he is satisfied or the goal is reached: *"I'm not thinking clearly here, I think. I'm just listening to the music and going from one thing to another, just handling whatever that needs [cleaning]. […] The general idea is to clear the floors for mopping but there's no specific logic to it, it's just noticing what needs to be done."*. Reasons for action switch/initiation were identified and coded as part of our coding structure (see Appendix for a complete codebook).

Our activity coding structure for the exploratory study enabled us to provide the research with a detailed account of the human activity granularities in everyday life. It also enabled us to identify a number of preceding instances for a micro-decision (e.g., freezing and pausing, hesitation, scanning and looking around, etc.). Upon coding the entire cleaning activity process for every detail, we concluded that when the activity is fluid, fast, and uninterrupted, participants either have little to no explicit experiences of MDM or they make decisions on a more general level, such as setting goals and sub-goals which then motivate activity initiation. A typical example of this is driving, through which participants do not experience deciding over which gear to shift into, but they remain aware of the general state of the car and the goal and sub-goals. However, when the fluid flow of activity is interrupted (whether for internal or external reasons), the reorientation process manifests with moments of pause, hesitation, and looking around to scan the environment. Such instances emerged as moments to focus on further in the main study, as we suspected that these are when experiences of MDM occur.

The identified variables for a micro-decision must be made explicit with observable criteria to make them identifiable and testable by other researchers. Following the coding process, we had our data re-coded by other researchers and continued refining the structure for the main study. Additionally, such an approach will enable a cross-task analysis, which in turn allows us to investigate if and how DM is experienced differently in various contexts throughout people's typical days. For example, a comparative analysis between a typical inconsequential everyday task (an unimportant activity with minor consequences and low stakes) and everyday administrative tasks (a more important activity with more consequences and higher stakes) will facilitate cross-task analyses.

Finally, it is also interesting to note that participants always seemed to be able to provide a rationale for the details of their actions and decisions, but that rationale might not necessarily have been developed at the moment of decision. Apparently, often, such rationale about how to perform the task has taken place once the first time and then was taken for granted in the repisodes (but did not disappear). All this opened perspectives on the nature of everyday behaviour and the grey zone between habits, preferences, and decisions. Our initial analysis also promised to shed light on the "dual processes" that DM literature describes, which we analysed further in the main study.

Insights Gained from the Exploratory Study

Following our exploratory study, we continued to refine and test, where possible, our proposed sets of variables, codes and categories and utilise them for an in-depth analysis of the activity process as the context in which numerous and various micro-decisions occur. Ultimately, we aim to identify, describe, and analyse moments of micro decisions from the subject's point of view.

The findings from the exploratory phase played a crucial role in shaping the subsequent stages of the research, guiding the refinement of the research design, sampling criteria, and focus of the main study. The insights gained from the thematic analysis of the Subcam footage and RIWs informed the following aspects of the research:

1. Identification of the focal activities:
    - The exploratory phase revealed that cleaning activities were common across participants, involved a high frequency of micro-decisions, and were often associated with subtle shifts in goals and sub-goals. We chose cleaning as a focus point for the exploratory study, which revealed significant focus areas for the main study.
    - This finding led to the decision to focus on typical everyday activities such as cleaning, cooking, commuting, etc. for the main study, allowing for a more in-depth investigation of MDM within a specific, everyday context.
2. Refinement of the sampling criteria:
    - The exploratory phase highlighted the importance of capturing a diverse range of experiences and perspectives to understand MDM in everyday life.
    - Consequently, the sampling criteria for the main study were expanded to include participants from various demographic backgrounds, ensuring a more representative sample in terms of age, gender, and culture.
3. Development of the RRIW protocol:
    - The insights gained from the exploratory phase informed the development of the Reinforced Replay Interview (RRIW) protocol, a novel extension of the SEBE methodology where participants code their own MDM (see Pilot Studies).
    - By analysing participants' experiences and DM processes in the exploratory study, we identified key decision points, behavioural markers, and subjective experiences that were incorporated into the RRIW protocol, enabling participants to code their own data and provide a more fine-grained understanding of their MDM processes.
4. Identification of additional activities for future pathways of the research:
    - While cleaning emerged as a primary focus, the exploratory study also revealed the potential value of investigating MDM in other everyday contexts, such as administrative tasks, as a future pathway for the research.

    - This finding informed the decision to include a comparative analysis of MDM in typical minor tasks and more cognitively expensive activities as a future pathway for the research, allowing for a more comprehensive understanding of how MDM may vary across different everyday contexts.
5. Refinement of the data analysis approach:
    - The TA conducted in the exploratory phase provided a foundation for understanding the key components and processes involved in MDM.
    - This initial analysis informed the development of a more structured, multi-stage data analysis approach for the main study, which included the identification of specific behavioural variables (e.g., pauses, hesitations, scans) and the use of statistical techniques to examine the relationships between these variables and MDM.
6. Formulation of initial theoretical insights:
    - The findings from the exploratory phase provided initial insights into the dynamic, context-dependent nature of MDM in everyday life, highlighting the importance of factors such as goal-setting, environmental affordances, and embodied competencies.
    - These insights informed the initial formulation of a basic activity model, which was further refined and elaborated through the subsequent stages of the research.

In conclusion, the exploratory study of our research provided a solid foundation for understanding the subjective experience of MDM in everyday life. By collecting and analysing SEBE data from participants engaged in their typical daily activities, we gained valuable insights into the key themes, patterns, and representative activities characterising MDM in real-world contexts. The findings from this phase, particularly the identification of cleaning as a focal activity and the emergence of initial theoretical insights informed the refinement of the research design, sampling criteria, and data analysis approach for the main study. Moreover, the exploratory phase laid the groundwork for developing the innovative RRIW protocol, which aims to provide a more fine-grained, participant-driven understanding of MDM processes. It also provided us with detailed verbatim and rich descriptions of participants' subjective experiences as they engaged in their daily activities. These descriptions then provided the groundwork for our RRIW protocol.

Building upon the insights gained from the exploratory study, we proceeded to conduct a series of pilot studies to refine the research methodology further and test the feasibility of the RRIW protocol. These pilot studies served as a crucial bridge between the exploratory findings and the main study, allowing us to validate and optimise the research design before embarking on the full-scale investigation of MDM in everyday life. The following section will detail these pilot studies' objectives, procedures, and outcomes, highlighting their role in shaping the final research design and setting the stage for the main study.

APPENDIX F) PILOT STUDIES

The pilot studies conducted in this research served as a critical intermediary stage between the exploratory phase and the main study, aiming to achieve the following objectives:

1. To test and refine the RRIW protocol:
    - The primary objective of the pilot studies was to assess the feasibility and effectiveness of the RRIW protocol, a novel extension of the SEBE methodology that involves participants coding their own data.
    - By conducting pilot RRIWs with a small sample of participants, we aimed to evaluate the clarity of the protocol instructions, the ease of use of the coding interface, and the overall participant experience.
    - The pilot studies also sought to identify any potential challenges or limitations of the RRIW protocol, allowing for necessary adjustments and improvements before implementing it in the main study.
2. To validate the coding scheme and behavioural variables:
    - The pilot studies provided an opportunity to test and validate the coding scheme and behavioural variables identified during the exploratory phase, such as pauses, hesitations, and scans.
    - By analysing the pilot RRIW data, we aimed to assess the reliability and consistency of the coding scheme across participants and to determine whether the selected behavioural variables were effective in capturing key aspects of MDM processes.
3. To assess the technical feasibility of the SEBE data collection and analysis:
    - The pilot studies also served to test the technical aspects of the SEBE data collection and analysis process, including the use of subcams, the transfer and storage of video data, and the synchronisation of video footage with RRIWs.
    - By conducting pilot studies, we aimed to identify and address any technical challenges or limitations, ensuring a smooth and reliable data collection and analysis process for the main study.
4. To evaluate the participant recruitment and sampling procedures:
    - The pilot studies provided an opportunity to assess the effectiveness of the participant recruitment and sampling procedures based on the refined criteria established during the exploratory phase.

    - By recruiting a small sample of participants for the pilot studies, we aimed to evaluate the feasibility of the recruitment process, the clarity of the study instructions, and the sample's representativeness.
5. To develop and refine the basic activity model (see Figure F9):
    - The pilot studies played a crucial role in developing and refining the basic activity model, which aimed to capture the key processes and components involved in MDM in everyday life.
    - By analysing the pilot RRIW data and participant feedback, we sought to identify the model's core elements, such as the concepts of fluid flow, diversion, disruption, and orientation.
    - The pilot studies provided an opportunity to test the model's explanatory power and make necessary adjustments and refinements based on the empirical data, ensuring that the model was well-grounded in participants' real-world experiences.
6. To develop a template for presenting research findings:
    - Another objective of the pilot studies was to develop a template for presenting the research findings in a clear, engaging, and accessible manner.
    - Our developed template aimed to integrate the SEBE video footage, participant verbatim, and analytical insights into a coherent narrative that effectively communicates the key aspects of MDM in everyday life.
    - By testing and refining several templates during the pilot studies, we sought to create a powerful tool for disseminating the research and enhancing the impact and reach of the study.
7. To identify potential improvements and refinements for the main study:
    - Finally, the pilot studies aimed to identify any potential improvements or refinements that could be made to the research design, methodology, or analytical approach before conducting the main study.
    - By carefully evaluating the outcomes and participant feedback from the pilot studies, we sought to make data-driven adjustments to optimise the main study and ensure its success in capturing the complexity of MDM in everyday life.

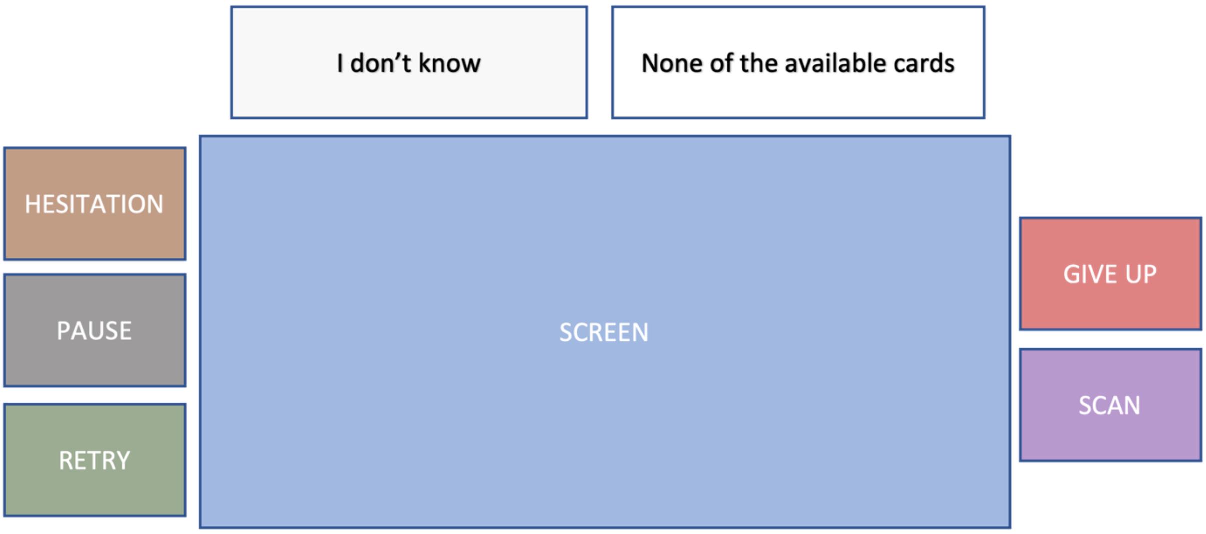
By achieving these objectives, the pilot studies not only bridged the exploratory findings and the main study but also played a vital role in developing and refining the basic activity model and creating an effective template for presenting the research findings. The insights gained from these studies informed the final adjustments to the methodology. They ensured that the research was well-equipped to investigate the subjective experience of MDM in everyday life, to contribute to the theoretical understanding of the phenomenon, and to effectively communicate the findings to a wide audience.

Test and Improvement of the RRIW Protocol

Aiming to rely less on the researchers' intuition and more on the participants' subjective experience, we developed seven cards based on the identified variables through our pilot study. The terminology used for the card titles and their description is developed based on a textual analysis of the open-ended description of the situations (see Exploratory Study). Following the content analysis of the verbatim, 7 cards were developed and put next to the screen for the RRIW. The card-based coding protocol included *Pause, Hesitation, Scan, Retry, Give Up, I don't know,* and *None of the cards*. The cards were inserted around the screen (see Figure F1).

Figure F1

Schematic (above) and actual (below) illustrations of the visual cues and their installation around the screen for the RRIW session

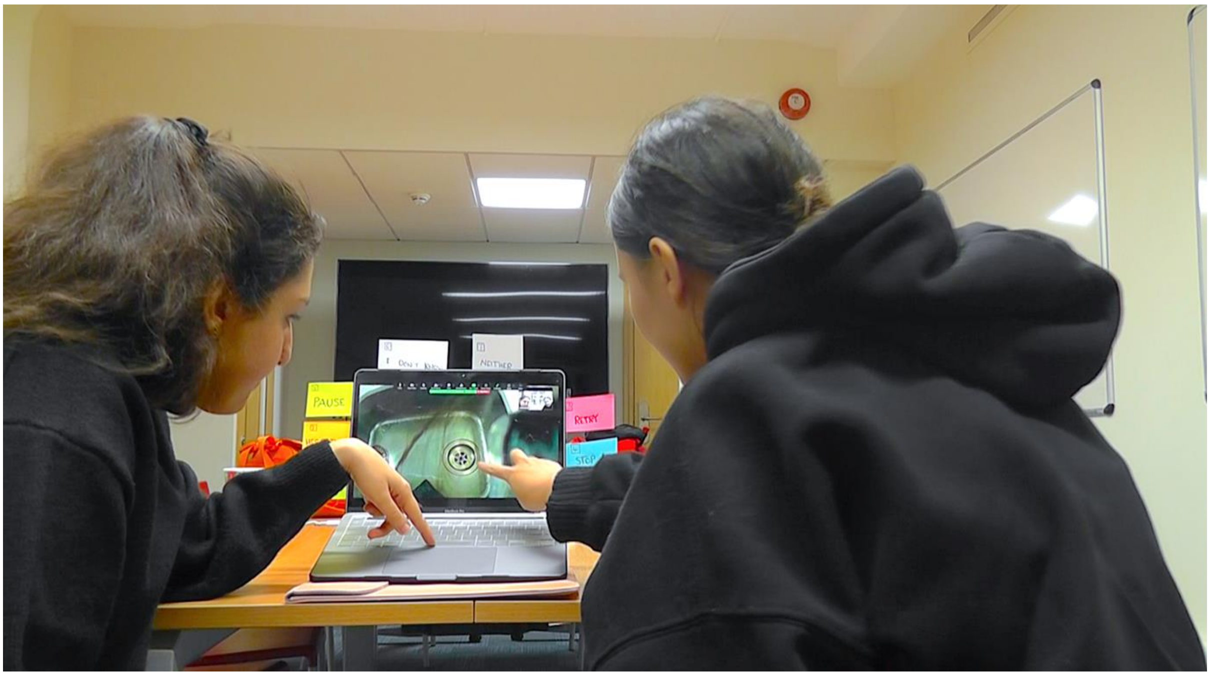


The RRIW protocol involves participants reviewing their own SEBE recordings and using the card-based system to code instances where they experienced a breach in the fluidity of their activity. Participants were instructed to pause the video whenever they noticed such a breach and then select the card that best described their subjective experience of the situation. Additionally, participants were asked to identify moments of subjective micro-decision.

For the pilot studies, two participants were recruited, and each participant coded approximately 30 minutes of their own Subcam footage. The participants were provided with detailed instructions on the card-based coding system and the RRIW process. The RRIW sessions were conducted in a controlled setting, with the researcher present to guide the participants and answer any questions. This rigorous process ensures the reliability of the results. Figure F2 is an illustration of the RRIW pilot study with one of the participants, showing how the participant used the cards as visual cues to code her own data and confirm moments of activity disruption and micro-decision.

Figure F2

The researcher and the participant during the RRIW pilot study. The participant is choosing the card which best describes the situation following a breach she noticed in the fluidity of her activity



We conducted the pilot studies to assess the feasibility and effectiveness of the RRIW protocol, a novel extension of the SEBE methodology. We identified key variables related to MDM, such as pause, hesitation, scan, retry, and give up. These variables were used to create a set of visual cues with titles and descriptions derived from participants' own language, as captured during the exploratory study. The SEBE data used in the pilot studies were collected using the same protocol as those used in the exploratory study. Participants wore subcams to capture first-person perspective video footage of their everyday activities, focusing on typical everyday tasks. The pilot studies aimed to test the RRIW protocol on a smaller scale before implementing it in the main study.

The pilot studies employed a mixed-methods approach, combining qualitative and quantitative analysis techniques. The RRIW sessions were analysed qualitatively using thematic analysis to identify common patterns and themes in participants' subjective experiences and MDM processes. The analysis focused on the content of participants' verbalisations during the RRIW sessions and their interactions with the card-based coding system.

Quantitative analysis was performed on the frequency and distribution of the selected cards across the coded SEBE data. This analysis aimed to identify the prevalence of different types of breaches in the fluidity of activity and the proportion of these breaches that were associated with subjective micro-decisions. Descriptive statistics, such as percentages and averages, were calculated to summarise the quantitative findings.

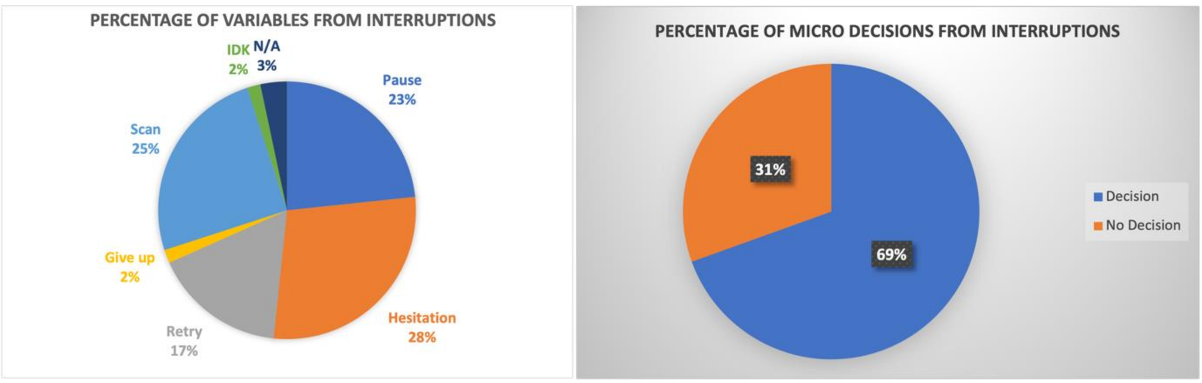
Validation of the Coding Scheme and Behavioural Variables

The pilot studies yielded several important findings. Firstly, the RRIW protocol proved to be effective in capturing participants' subjective experiences and MDM processes. Participants could use the card-based coding system to identify and categorise breaches in the fluidity of their activity. They also successfully identified moments of subjective micro-decisions.

The two participants coded 59 instances of breaches in the fluidity of activity across 32 minutes of cleaning activity. This suggests that, on average, interruptions in the flow of activity occurred approximately every 30 seconds. Notably, 69% of these breaches were experienced as micro-decisions by the participants, highlighting the prevalence of MDM in interrupted flow. The figure below is a visualisation of our basic descriptive analysis from the pilot study.

Figure F3

Descriptive statistical analysis of the RRIW pilot study



We continued conducting more RRIWs through the main study (see Main Study) to analyse the results further and amend the protocol as necessary. The following link includes samples of the RRIW pilot study: https://shorturl.at/QA3cp.

The qualitative analysis of the RRIW sessions revealed common themes in participants' experiences of MDM. Participants frequently described moments of hesitation, pausing to scan the environment, and retrying actions when faced with obstacles or uncertainty. They also reported a sense of satisfaction or completion when a micro-decision resulted in a successful outcome or when a task was finished.

The quantitative analysis demonstrated the reliability and consistency of the coding scheme across participants. The selected behavioural variables (pause, hesitation, scan, retry, and give up) effectively captured key aspects of the MDM process, as evidenced by their frequent occurrence in the coded data.

Assessing the Technical Feasibility of SEBE Data Collection and Analysis

We often observed throughout the RRIW sessions that participants took control of rewinding and pausing the footage without the need to ask them to. They proactively paused the footage whenever they experienced a breach in their activity flow and used the visual cues around the screen to code their subjective experience of the situation. Thus, it was of utmost importance to ensure that participants had access to an additional keyboard and mouse and could conveniently control the Subcam footage playback. The images below illustrate our updated RRIW setting followed by images from participants taking control of the footage and pointing towards the behavioural code that best described the subjective experiences of the disruptions and reorientation.

Figure F4

An updated RRIW setting based on the findings of the pilot study

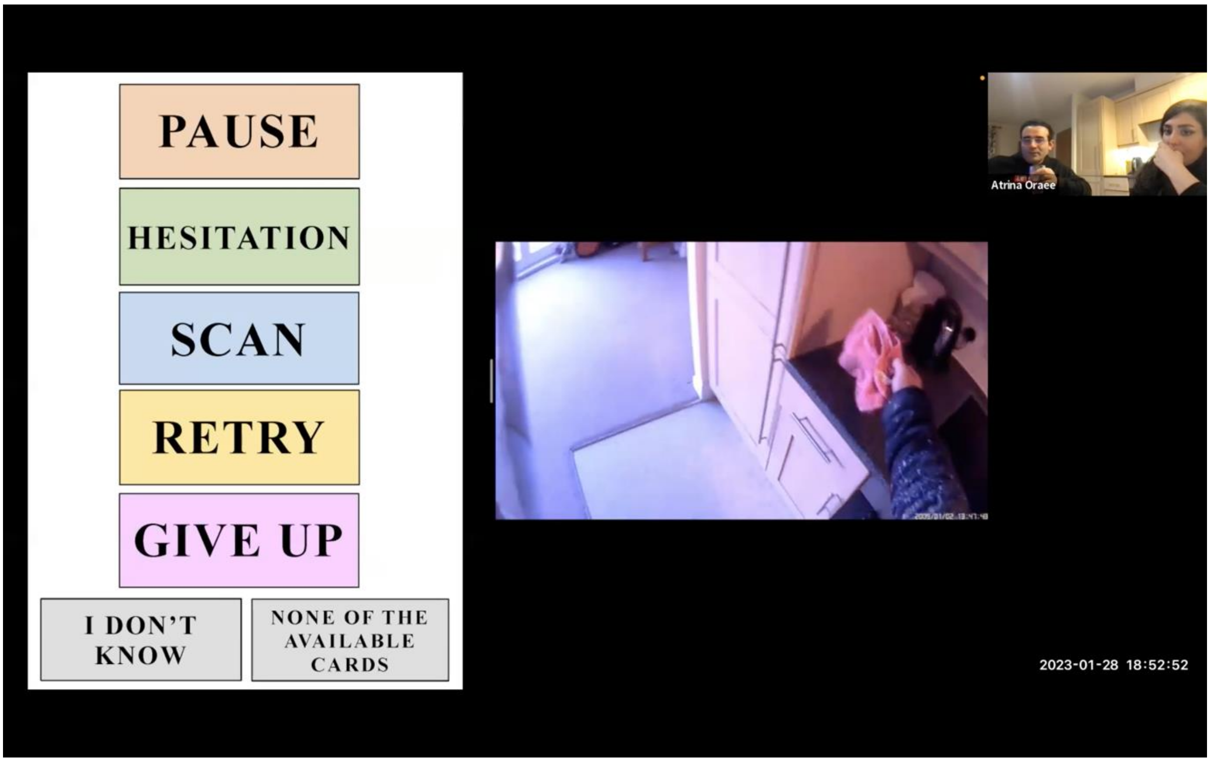
Figure F5

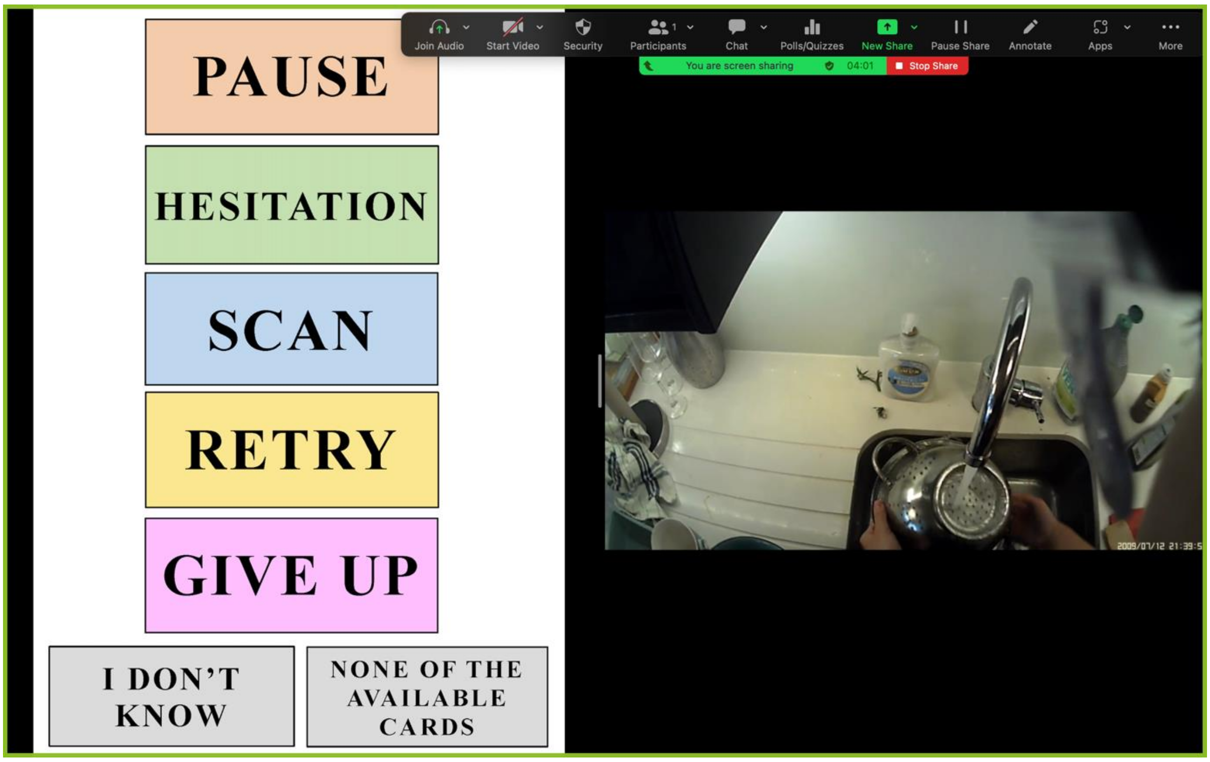
Images of RRIW sessions demonstrating how participants took control of the footage and paused whenever a micro-decision occurred and pointed towards the card which best described the subjective experience of the situation

Moreover, in situations where in-person RRIW sessions were not possible, an online session was conducted with electronic copies of the behavioural codes arranged around the shared desktop view to make the protocol easier to carry out. The same RRIW procedure was then followed. Through such a remote design, we managed to conduct RRIWs with participants from whom we no longer had access due to physical distance. Such a protocol can be followed using any video conferencing platform such as Zoom, Google Meet, etc. The below image shows an online RRIW session with a participant.

Figure F6

Online RRIW sessions with the digital behavioural code cards arranged next to the footage for the participants' viewing





Evaluating Participant Recruitment and Sampling Procedures

During the pilot studies, we evaluated the effectiveness of our participant recruitment and sampling procedures based on the refined criteria established during the exploratory phase. To ensure a diverse and representative sample, we focused on recruiting participants from multiple cultural backgrounds while controlling for gender.

We employed a purposive sampling strategy to identify and recruit potential participants who met our refined criteria. This approach allowed us to target individuals from various cultural backgrounds, ensuring a balanced representation of different ethnicities and nationalities. By actively seeking out participants from diverse cultural contexts, we aimed to capture a wide range of perspectives and experiences related to MDM in everyday life.

To control for gender, we attempted to maintain a balanced ratio of participants who identified as male or female in our pilot study sample by setting recruitment quotas and monitoring the gender distribution throughout the recruitment process. This helped minimise potential biases in our dataset and findings.

The recruitment process involved distributing study information through various channels, such as social media and community networks, and utilising researchers' personal connections. We also relied on snowball sampling, encouraging existing participants to refer others from their cultural communities who might be interested in participating. This approach helped us reach a wider pool of potential participants.

We assessed the cultural diversity of the sample by collecting information on participants' ethnic backgrounds, nationalities, and languages spoken. This data allowed us to gauge the representativeness of our sample and make any necessary adjustments to the recruitment strategy. We also sought feedback from pilot study participants regarding their experience with the recruitment process and the clarity of the study instructions, which provided valuable insights into the accessibility and inclusivity of our recruitment materials.

By the end of the pilot studies, we had successfully recruited a culturally diverse sample of participants with a balanced representation of genders. The evaluation of our recruitment and sampling procedures confirmed the feasibility and effectiveness of our approach in attracting participants from multiple cultural backgrounds while controlling for gender. This diverse sample allowed us to capture a rich tapestry of experiences and perspectives related to MDM in everyday life, strengthening the validity and generalisability of our findings.

The insights gained from the pilot studies informed the final adjustments to our recruitment and sampling strategies for the main study, ensuring the successful recruitment of a diverse and representative sample.

The Initial Activity Models from the Pilot Studies

Through our pilot studies, we refined our methodology with the RRIW sessions. We then used this RRIW to analyse instances in which the fluid flow of activity was breached. We obtained an interpretation from the participants, hereby getting the subjective rating of their mental processes. This illuminated key aspects of MDM in everyday life, uncovering which identified behavioural events precede moments of subjective experiences of MDM. This journey through data validated some of our initial hypotheses but also revealed unexpected patterns, laying fertile ground for further inquiry. Our investigation led to a basic activity model (Figure X), which enabled us to identify instances of a micro-decision throughout the activity process and throughout a situation. It further illuminated that several forms of activity can be identified, such as fluid, disrupted, etc. and the importance of investigating MDM through the activity process rather than considering such decisions in an isolated investigation. The Figures below illustrate our first version of the activity model, followed by a revised version.

The pilot studies followed the first activity model that emerged from them, enabling us to identify instances of a micro-decision throughout the activity process in a given situation. We demonstrated two distinct types of activity, with one being fluid, fast, automatic, and easy, through which the participant is very much channelled through the installations and does not need to think consciously of the next action since the situation is conducive to the next action(s). The participant seems *"in the flow"* of the activity, and the mind is primed because the action at hand triggers the next action(s). Otherwise, there are constantly numerous possibilities and actions that the participant can engage in, but the action currently doing primes the brain, and thus other relevant possibilities are activated. In other words, the brain is primed by what the participant is doing, and thus a set of relevant opportunities and action(s) are triggered and considered, whether consciously or not. We believe the reason for which the brain is primed is that the activity in which the participant is engaged acts as a massive attractor, which is why the participant remains indifferent to all the other attractors in the environment. They don't seem to trigger action or successively grab the participant's attention. Such orientation occurs continuously as the participant pursues satisfaction. Such fluid activities are often straightforward, simple, and familiar to the participant; as Participant 3 described, *"Much like running, for that matter, I just turn off my brain, and there is not much active thinking going on. [...] I mean, the whole cleaning thing is amazing, because I'm always able to turn off my brain because it kind of somehow happens"* Fluid flow is a massive resonance of the entire brain throughout a specific activity. Hence, it is seldom distracted or disrupted since everything is very much tuned and in place. We believe this is why becoming distracted or disrupted when you're very much in the flow is tricky, and we see fluid actions in often easy and small tasks.

Despite an otherwise fluid flow of activity, we sometimes see a minor diversion, though the participant quickly returns to the goal pursuit. A small flow is occurring on the side of the main activity flow. Such **diversions (2.2)** are various ways of doing the same activity without having to change the activity entirely and without facing an intersection or choice. The participant appears to be attempting to orient towards the best possible path towards the goal after evaluating (here, unconsciously) the situation. In such instances, there is no change in intention. The original motive/goal is maintained, but the participant is unconsciously and automatically orienting and slightly rerouting based on a relevant opportunity that has revealed and successively attracted the participant's attention through their heavily primed brain. Participant 2 explained: *"[I went to the table] to take the plates, but I also change the music because I'm already there so Ithought I might as well, and then I go for the cabbage [in the fridge]."* Such opportunities are often with the intention of saving physical and cognitive resources and often require very few of such resources without the necessity to reassess the situation. In other words, the participant keeps on the same main track but does something slightly different to the action. Here, they are not facing an intersection in the process. Additionally, as long as the task at hand is easy and small, the brain can handle more attractors in addition to the main one, which also happens to prime the brain. So, if the participant thinks they can handle another attractor, they engage in a minor **"add-on" (2.2)** action. Participant 1 gave an example of an add-on opportunity while he was cleaning, explaining "*I really like fresh air so, like, while I'm cleaning, might as well add in some fresh air."* If this is too disturbing, it becomes a **disruption (3)**, leading the participant to recalculate or restabilise the attractor. Participants appear to take in as much as they "feel" they can handle. Such an attempt to act efficiently and optimise resource use is rooted within human beings' evolutionary aspects.

A massive breach in the flow of activity disrupts the activity, leading the participant into an intersection where they need to rethink the following action(s). This calls for restabilising and recalculating the attractor and orienting towards the goal. We observe this in our data through long pauses and frequent head movements, which indicates scanning the situation and environment and exploring the possibilities. We believe that in such instances, the participant is looking for affordances. This will lead to another intersection in which the participant must decide whether to abandon the goal pursuit or change the activity while still pursuing the goal. In other words, the participant is not doing the same activity as before but is still pursuing the same goal.

We suspect the participant does not consider the possibility of entirely stopping an activity until the flow is disrupted. This is often when the possibility of abandonment is considered, and perhaps the activity is abandoned if pursuing the goal is "not worth it" anymore. This requires thinking and calculation.

While the environment causes an **external disruption (3.2)**, an **internal disruption (3.1)** occurs by the actor. We observe external disruptions as either a distraction due to an environmental cue (e.g., the participant heard something, saw something, smelled something, etc.) or simply because the environment was not conducive to the following action(s) and could not physically afford them. This, in turn, requires the participant to reorient towards the goal.

If such orientation occurs without a problem and the participant maintains sufficient motivation, then the goal pursuit can continue though we see a complete change in the activity. If not, then the activity is abandoned. Internal disruptions can, and often do, include proactive self-distractions, procrastination, short breaks from an activity, and other instances that indicate a lack of sufficient motivation from the participant. We suspect massive amounts of computation and calculation going on when the activity flow is disrupted for the participant to orient themselves again towards the goal. At every intersection throughout the activity, the participant may stop and abandon the task prematurely or continue the activity. In cases where the participant fails to identify any possibilities for action or affordances, they then appear to engage in a problem-solving endeavour requiring their creativity, skills, and past experiences to solve. This, again, requires a massive amount of calculation. We frequently observe such endeavours when the participant is faced with a situation for the first time or is very much unfamiliar with the situation. We then observe a process of manipulating the environment to solve the problem, or as the participant explain themselves, "figure out" the situation as they orient themselves towards the goal.

We suspect that massive orientation towards the goal requires some subjective and conscious micro-decisions from the participant. Intersections throughout the activity process where the flow of the activity is massively breached and thus disrupted require thinking and rerouting while trying to figure out the following action(s), assuming that the activity is not abandoned.

The first version of the model we proposed was based on the initial analyses of the data. We then coded and analysed Subcam footage from a variation of everyday mundane activities and collected more data. We then developed an additional step in the SEBE methodology to test the identified variables in the data (see the following section). Upon coding all the data and gaining some statistical insight into the dataset as well as analysing the reorientation instances in detail with the participants, we modified the model and proposed a revised version (see Figure X). When analysing the **Retry (2.1)** behaviour (see above for an example), we found that retrying the same action is participants' initial reaction to any kind of obstruction that they encounter anywhere throughout the activity. It seems like an automatic reaction that might resolve the obstruction. Upon successful removal of the obstruction, there is no longer a need to reassess the situation and reorient, thus the activity flow remains fluid and no explicit experiences of MDM is explained or confirmed. This also explains the negative correlation between retrying and experiences of MDM. As long as the automatic retrying works, the activity remains fluid and uninterrupted. Once retrying, as a first solution, does not remove the obstruction, then a problem is perceived, the situation needs to be reassessed, and the flow of activity is disrupted. Participant 33 explained how she retried to open the lid of a jar several times without having to take any micro-decisions: "*So this is also a retry because I find the lid was too slippery, so I tried to open it, but I failed the first time, and then I succeeded in a second"* Similarly, Participant 15 explained retrying to get the right temperature: *"Yeah. I remember that I retry for several times. I retried to adjust the temperature."*

When retrying does not resolve the obstruction or satisfy the goal or motive, then a reassessment of the situation is required, leading to explicit experiences of MDM since the flow is disrupted and reorientation is required by the participant. Participant 7 explained having to think of a solution after not being able to find any washing machine liquid to do the laundry. After retrying to find any suitable affordance, he made a micro-decision to go to the store and buy some: *"I didn't know there is no detergent. I tried to find some. I'm looking everywhere to find something but nothing was there, so I decided to go and buy some. […] Yes, I was scanning initially, but then retried looking in the same places for several times before I knew I have to do something about it."* Based on such findings, we proposed a revised version of our basic activity model (see Figure F9).

Figure F8

First version of activity model based on preliminary findings

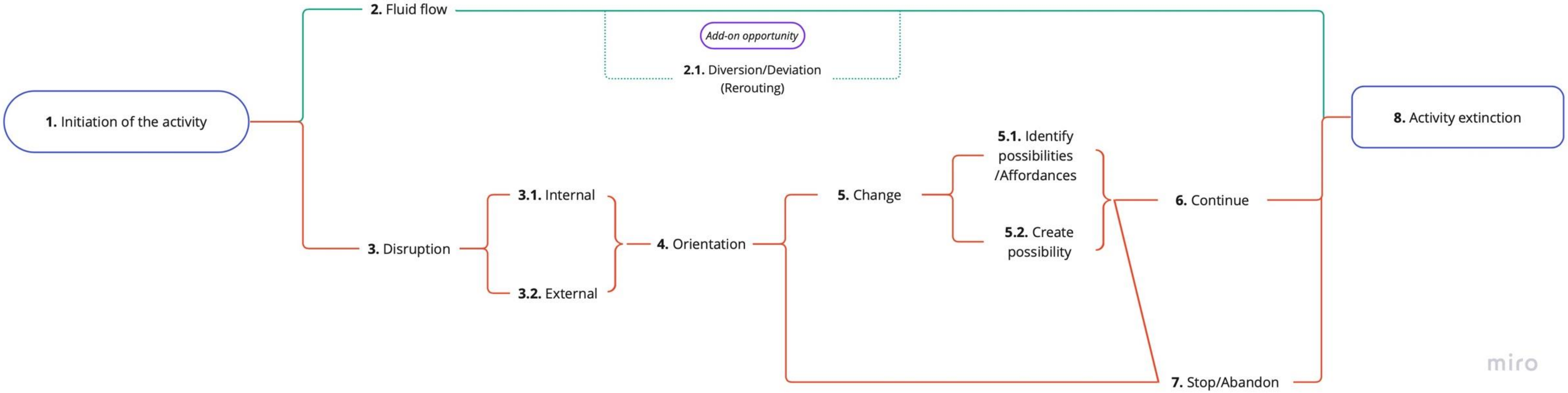
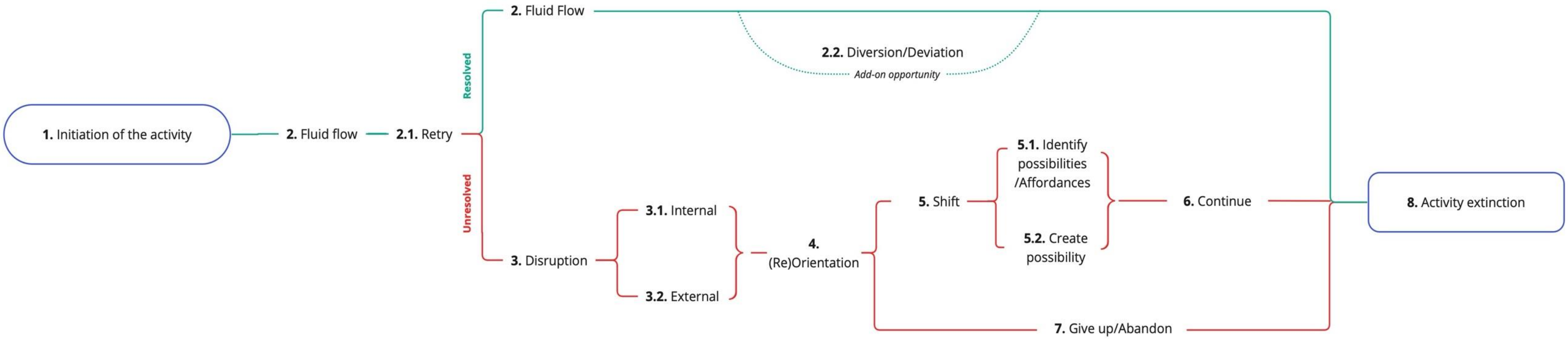


Figure F9

Modified activity model



The pilot studies provided valuable insights into the nature of MDM in everyday life, leading to the development of our initial activity models. These models allowed us to identify instances of micro-decisions throughout the activity process and situate them within the broader context of fluid and disrupted activity flows. The models also highlighted the importance of investigating MDM through the lens of the activity process rather than treating decisions as isolated events.

However, our proposed models were not without limitations. The analysis of the "Retry" behaviour revealed that it often served as an automatic, initial reaction to obstructions encountered during an activity. When retrying successfully resolved the obstruction, the activity flow remained fluid, and participants did not report explicit experiences of MDM. This finding challenged our initial conceptualisation of the role of "Retry" in the MDM process and prompted us to reconsider its placement within the activity model.

Similarly, the "Give Up" behaviour, which we initially thought to be a clear indicator of MDM, proved to be more complex than anticipated. Participants sometimes abandoned activities without engaging in explicit MDM, suggesting that the relationship between "Give Up" and MDM was not as straightforward as we had assumed.

These issues with "Retry" and "Give Up" led us to question the linearity of our proposed models and prompted us to revisit our coding scheme. We realised that to capture the full complexity of MDM in everyday life; we needed to code our entire dataset from scratch, paying close attention to the behaviours that followed instances of MDM in light of our proposed model (e.g., what behaviour followed a pause, etc.). With this agenda in mind, we embarked on our main study, aiming to delve deeper into the proposed models and refine our understanding of MDM. The main study sought to address the limitations identified in the pilot studies by employing a more comprehensive coding scheme, a larger and more diverse sample, and a more iterative approach to data analysis and model development.

In the following section, we will discuss the amendments and refinements we implemented for the main study based on the insights gained from the pilot studies. We will then delve into the details of our main study, including our revised coding procedures, the application of the refined RRIW protocol, and the insights gained from this in-depth investigation of MDM in everyday life.

Identifying Potential Improvements and Refinements for the Main Study

The pilot studies shed light on potential limitations and areas for improvement in the RRIW protocol. Some participants reported difficulty in distinguishing between certain card categories, such as hesitation and pause, while others suggested that additional contextual information could be helpful in interpreting their subjective experiences. These insights informed the refinement of the RRIW protocol for the main study.

Based on the findings and implications of the pilot studies, several amendments were made to the research design:

1. The RRIW protocol was refined to improve clarity and ease of use. The card descriptions were revised to minimise ambiguity, and participants were provided with additional guidance on differentiating between similar categories (e.g., hesitation vs. pause).
2. The sampling criteria for the main study were expanded to include a more diverse range of participants, considering factors such as age, occupation, and culture. This amendment aimed to enhance the generalisability of the findings and capture a broader spectrum of MDM experiences.
3. The data analysis plan was refined to incorporate a more in-depth qualitative analysis of participants' verbalisations during the RRIW sessions. This included using thematic analysis to identify patterns and themes related to the subjective experience of MDM and the contextual factors that influence these experiences.
4. The scope of the main study was broadened to include a comparative analysis of MDM across different everyday contexts, such as cleaning activities and administrative tasks. This amendment aimed to explore the potential variations in MDM processes and experiences across different types of activities.
5. The sample size for the main study was determined based on the insights gained from the pilot studies, considering the richness and depth of the data obtained through the RRIW protocol. A larger sample size was deemed necessary to capture a sufficient range of MDM experiences and allow meaningful comparisons across different contexts and participant characteristics.

These amendments were designed to enhance the main study's robustness, ecological validity, and analytical depth. By incorporating the lessons learned from the pilot studies, the research design was optimised to better capture the complexity and nuances of MDM in everyday life.

The pilot studies were a critical step in developing and refining the RRIW protocol, demonstrating its feasibility and effectiveness in capturing participants' subjective experiences and MDM processes. The findings highlighted the prevalence of MDM in everyday activities. They revealed common themes in participants' experiences, such as hesitation, scanning the environment, and retrying actions when faced with obstacles or uncertainty.

Building upon the insights and lessons learned from the pilot studies, the main study aimed to provide a more comprehensive and in-depth investigation of MDM in everyday life. The refined RRIW protocol, validated coding scheme, and optimised research design were employed to capture the richness and complexity of participants' subjective experiences across a diverse range of everyday activities and contexts.

In the following section, we will delve into the details of the main study. The main study aims to provide a more nuanced and robust understanding of the complex interplay between activity flows, disruptions, and MDM in naturalistic contexts by building upon the foundation laid by the pilot studies and addressing their limitations.

Summary of the Reliability Tests

In summary, our study involved recording and coding various behavioural variables, such as pause, hesitation, retry, give up, scan, etc., in our footage. Researchers coded breaks in the fluidity of activity, the behavioural variable that explained the situation, and whether the break was a micro-decision. Upon completion of the coding, we then provided the developed and refined codebook to 2 additional researchers, along with random selections of the Subcam footage. We then asked the researchers to code the footage using our codebook. The main statistical measure used to determine the intercoder reliability was Cohen's Kappa, which provides a more accurate measure of agreement by accounting for the possibility of the agreement occurring by chance. The tables below summarise the findings from our reliability tests for Research 2 and 3.

Table F1

Summary of the intercoder reliability tests for Researcher #2

Researcher 1 Initials	AO
Researcher 2 Initials	FH
Total Duration of Footage Coded	04:32:37 of Set B
% of Total Footage	8%
Total Instances Coded	279
Total Agreement	239
Total Disagreement	40
% of Compatibility	85.66
Cohen's Kappa	0.809

Table F2

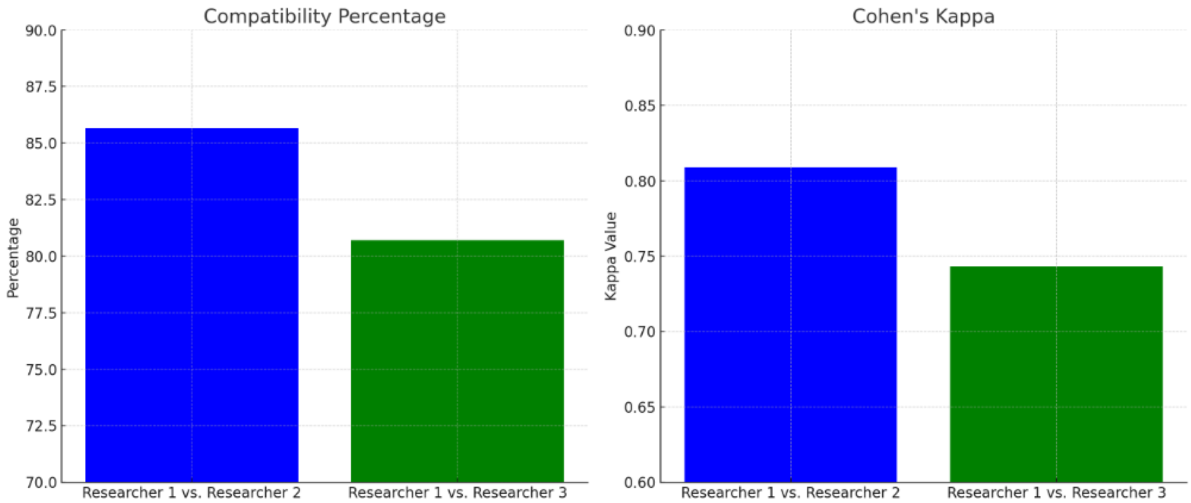
Summary of the intercoder reliability tests for Researcher #3

Researcher 1 Initials	AO
Researcher 3 Initials	NL
Total Duration of Footage Coded	04:19:31 of Set B
% of Total Footage	7%
Total Instances Coded	342
Total Agreement	276
Total Disagreement	66
% of Compatibility	80.70
Cohen's Kappa	0.743

The below visualisations represent the above comparisons graphically, focusing on compatibility percentages and Cohen's Kappa values.

Figure F10

Visually representations of the findings from the intercoding reliability assessments



The Compatibility Percentage chart shows how often the researchers agreed in their coding, with Researcher 1 and Researcher 2 achieving higher compatibility compared to Researcher 1 and Researcher 3. The Cohen's Kappa chart further solidifies these results, illustrating very good to good agreement levels quantified by the Kappa statistic.