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# Likelihood and familiarity in the simulation of future events

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**Abstract**

Episodic future thinking is the ability to project the self forward in time to pre-experience an event (Atance & O'Neill, 2001). Understanding how people think about potential future events is an important component of human memory research. We investigated whether and how episodic future thinking is influenced by a person's belief of the likelihood of its future occurrence in their lives, as well as a person's familiarity with that type of event based on their past experience. The combined and individual effects of these variables have been minimally studied, particularly likelihood. We used three norming studies to develop participant-specific sets of future events that varied by likelihood and familiarity. Participants generated events and rated phenomenological aspects of their simulations. Likelihood and familiarity interacted in influencing people's simulation of future events, specifically on the simulated perceptual information. Both variables influenced episodic future event simulations on their own as well. The enhancement of future event simulations by the likelihood of an event occurring in a person's future suggests that it is an important part of the underlying mechanisms that support episodic future thinking.

**Keywords**

Episodic future thinking, likelihood, familiarity, events

## Lay Summary

People think about their future every day, and for that, it is known that they use information that comes from similar past experiences. In fact, remembering our past and simulating our future is built on similar information. However, the past and the future are different; the past is certain, but the future is yet to be known. There are two important parts of thinking about the future. One is about putting together known information, and the other is about aligning that information to what we expect to happen. An unanswered question concerns whether we think differently about future events according to how likely they are. We found that when events are well known, the increased likelihood of their occurrence makes them more vivid in our minds. We also found that regardless of how familiar events are, their likelihood of occurrence helps us produce more detailed and clearer pictures of what we think may happen.

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**List of Abbreviations**

| Abbreviation | Meaning |
|---|---|
| AI | Autobiographical Interview |
| ANOVA | Analysis of variance |
| CESH | Constructive Episodic Simulation Hypothesis |
| *df* | Degrees of freedom |
| e.g. | exempli gratia (for example) |
| EFT | Episodic Future Thinking |
| H-F | High familiarity |
| H-L | High likelihood |
| L-F | Low familiarity |
| L-L | Low likelihood |
| *M* | Mean |
| Max | Maximum |
| MFamiliarity | Mean of familiarity values |
| Min | Minimum |
| MLikelihood | Mean of likelihood values |
| N | Number of participants |
| *p* | Probability |
| PSM | Propensity scores matching |
| *r* | Correlation coefficient |
| *SD* | Standard deviation |
| SMS | Self-Memory System |

| | |
|---|---|
| T-stat | t-statistic |
| Z | Z-test |
| $\eta^2p$ | partial eta squared |

# Chapter 1

## 1.1 Introduction

The study of human memory has played a central role in cognitive psychology and cognitive neuroscience for a long time. Memory is fundamental to virtually all aspects of human behaviour, including making sense of your past, understanding what is happening to you at the moment, and thinking about what might happen in your future. The vast majority of research on human episodic memory has focused on memory for, or attempting to relive, past experiences. However, researchers more recently have begun to study how memory for past events allows people to think about their future. Thinking about the future is a pragmatic process that affects people's present behaviour and how they plan their future actions (Baumeister et al., 2016). Thinking about future events implies using knowledge through what researchers have called the “prospective brain”(Schacter et al., 2007). It also implies forming notions about what to expect in one's future because, although related to the past, the future is not a reproduction of it, and uncertainty is expected. Hence, simulating the future is a complex and multidimensional process that is an important component of human behaviour.

The ability to project the self forward in time to pre-experience an event is known as episodic future thinking (EFT), and it is rooted in Tulving's characterization of episodic memory (Atance & O’Neill, 2001). To project into future scenarios, we use information about what we already know from our past, including direct experience (Gamboz et al., 2010; Schacter & Addis, 2007) and other sources such as conversations with people, movies, videos, and other media (Anderson, 2012). Given that people's experiences differ, familiarity with types of events differs across individuals based on their knowledge. Familiarity with past events may translate into differences in the knowledge on which people can draw to think about future events. For example, there may be relatively likely future scenarios about which we have very little previous information but still need to anticipate because they are part of what we expect to happen (D'Argembeau & Mathy, 2011). We refer to the degree to which an event is expected to happen in a person's future as its likelihood.

Familiarity with an event and the likelihood of it happening in a person's future vary across events and individuals. In addition, many young adults may be highly familiar with events that are more ("Give a talk to a group of people") versus less likely ("Sit on Santa's lap in a mall") to happen in their future. Similarly, they may be unfamiliar with events that are more ("Get a mortgage") versus less likely ("Watch penguins in the wild") to occur in their own futures. Researchers typically have studied likelihood and familiarity as though they cannot be decoupled; that is, familiar events are also likely and unfamiliar events are unlikely (Szpunar & McDermott, 2008). For example, Anderson (2012) studied how likelihood and familiarity influence how people simulate future events. However, Anderson did not address either the isolated or combined effects of the variables. Thus, the individual and combined effects of familiarity and likelihood have not been fully studied yet.

In the present research, we conducted three studies to investigate the individual and combined effects of familiarity and likelihood on how people simulate future events. We expected to find that both variables contribute and interact to enhance episodic future thinking.

1.2 Episodic Future Thinking

EFT is the ability to project oneself into the future to pre-experience an event (Atance & O'Neill, 2001). This process is viewed as the combination of autonoetic consciousness[1] and episodic memory (Schacter et al., 2012). Whereas episodic memory enables a person to transport

[1] The definition of autonoetic consciousness appears later in this section.

at will into their personal past and the future (Tulving, 1993), autonoetic consciousness gives rise to remembering in the sense of self-recollection in mental re-enactment (Gardiner, 2001).

In 1972, Tulving proposed what would later be one of the theoretical bases of EFT: the functioning of episodic memory. According to Tulving, episodic memory enables "mental time travel," which means that people "Can transport at will into the personal past, as well as into the future" (Tulving, 1993, p. 67). Tulving's work laid the foundation for more recent research that has examined the role of episodic memory in thinking about the future and its relationship with recalling the past.

Tulving (1983) termed autonoetic as a self-knowing consciousness expressed in experiences of mental time travel, as in the mental reinstatement of previous personally experienced events. According to Lehner and D'Argembeau (2016), autonoetic consciousness during the simulation of future events depends on the extent to which people can meaningfully place imagined events in an autobiographical context.

Autonoetic consciousness plays an important role in distinguishing EFT from other similar types of mental simulations such as atemporal events, imagination, daydreaming, and counterfactual thinking. Atemporal events are simulation of events with no reference to a location in time (de Vito et al., 2012). Imagination are fictitious events that are not linked to past or future autobiographical memory (Hassabis et al., 2007). Daydreaming or mind-wandering are task-unrelated simulations that shift away from personal goals (Berntsen & Jacobsen, 2008). Finally, counterfactual thinking refers to imagining alternatives to reality that need not involve future or past personal episodes (Madore et al., 2014; Schacter et al., 2012; 2015).

Two theories are related closely to our research, the Constructive Episodic Simulation Hypothesis (CESH; Schacter & Addis, 2007) and the Self-Memory System (SMS; Conway &

Pleydell-Pearce, 2000). CESH states that if memory depends on construction rather than reproduction, both past and future thinking are constructed over the same information, and therefore, are similar processes. The evidence concerning the neural overlap when thinking about past and future events suggests a similar mechanism and, therefore, a single type of episodic processing "placed" at different times: future and past. Addis et al. (2007) studied processes of elaboration (i.e., retrieving or imagining supplementary details) and construction (i.e., the search and reconstruction of a past event or the creation of a future event) during both re-experiencing and pre-experiencing events. They found that the left hippocampus and posterior visuospatial regions were engaged in recall *and* future thinking during event construction. Furthermore, they found overlap in regions comprising the autobiographical memory network, attributable to the common processes engaged during elaboration, including self-referential processing, contextual and episodic imagery.

Due to the evidence for overlapping regions used during past and future thinking, in the present study we hypothesized that people rely on previous knowledge to construct their simulation. Thus, future events will be more or less influenced by their relation to past experiences. We expect that higher familiarity with a type of event will improve people's ability to simulate an event occurring in the future.

Although similar, past and future thinking also involve distinct components of neural activity. For example, Addis et al. (2007) found that thinking about future events recruited regions involved only in prospective thinking and generation, specifically the right frontopolar cortex and left ventrolateral prefrontal cortex, respectively. Furthermore, future event construction uniquely engaged the right hippocampus, possibly due to the novelty of these events. Distinctiveness between recall and future thinking leads us to consider that other processes may also be related to improving the mental simulation of future events.

Studies of autobiographical memory are also relevant to understanding future event thinking. Conway and Pleydell-Pearce's (2000) SMS is a conceptual framework that emphasizes the interconnectedness of self and memory, and highlights that memory is motivated because cognition is driven by goals (Conway, 2005). Although SMS was not designed to explain EFT, the proposed mechanisms may help to frame questions about how people simulate the future in their daily lives.

SMS consists of two main components, the working self, and the autobiographical memory knowledge base, they interact to form specific autobiographical memories. Conway (2005) uses the concepts of coherence and correspondence, which work as contradictory demands: while "one (…) represents reality as this is experienced, but in cognitively efficient ways" (correspondence); coherence acts "to retain knowledge in such a way as to support a coherent and effective process" (p. 596). Applying this framework to EFT, coherence demands are particularly useful to consider because they suggest that memory must be coherent with an individuals' current goals, self-image, and self-beliefs. In this regard, D'Argembeau and Mathy (2011) found that personal goal-related cues enhanced the simulation of future events. We hypothesize that likely events will be more coherent with memory systems because they align with personal goals, so that the likelihood of an event will be positively related to the simulation of future events.

In summary, whereas CESH explains the similarities between simulating the future and remembering the past, it does not focus on explaining fine-grained differences between them.

From this point of view, SMS provides cues regarding how likelihood might influence future thinking.

1.3 Familiarity and Likelihood

Studies of EFT have focused on several variables that could influence the amount and types of information that people generate when simulating future scenarios. There are, for example, studies on age differences (Addis et al., 2008; Cole et al., 2013), culture (Wang et al., 2011), emotions (Comblain et al., 2005; Vella & Moulds, 2014), anxiety and depression (Ito et al., 2019; MacLeod et al., 1997), gender (Wang et al., 2011), familiarity (Anderson, 2012; Robin & Moscovitch, 2014; Szpunar & McDermott, 2008) and likelihood or plausibility (Andersen et al., 1992; Anderson, 2012). Here we focus on familiarity and likelihood because of their relevance for EFT. Authors such as Conway, 2001; D'Argembeau, 2015; and Lehner and D'Argembeau, 2016 propose two main components of EFT: one that refers to knowledge collected from episodic memory, and another that refers to dynamically locating this knowledge in an autobiographically coherent future context.

Familiarity with an event refers to the amount of experience and knowledge about a type of event (Anderson, 2012), from physical details to overall meaning. On the other hand, likelihood refers to the plausibility of an event in a specific person's future. As was mentioned above, these variables are correlated to a degree. In previous research on EFT, they are usually coupled, meaning that events simulated are either familiar and likely such as "Going on a picnic," or unfamiliar and unlikely as in "Going on an Arctic trek." The study of familiarity has provided important support for the CESH hypothesis. In addition, we believe that likelihood may also play a relevant role in understanding EFT mechanisms.

Szpunar and McDermott (2008) asked participants to simulate events in locations that were either familiar (home) or unfamiliar (North Pole) and found that familiar settings enhanced detailed images of the future and led to a stronger subjective experience. They suggested that the contents of memory are sampled routinely during the construction of personal future scenarios. DeVito et al. (2012) obtained similar results. In addition, they included Autobiographical Interview (AI) measures and found that future events occurring in familiar settings included significantly more internal (episodic) details.

Anderson (2012) investigated how EFT is influenced by sources of familiarity, including direct personal experience, second-hand experience from other people, and various forms of media. Anderson also explored the effect of event plausibility. Undergraduate participants were provided with two plausible scenarios: "Your graduation day" and "First day in your graduate job." Participants also were provided with one unfamiliar and implausible scenario: "Your first trip into space." Although Anderson considered likelihood (or plausibility), investigating its effect independent from familiarity was not the study's aim. Anderson found that familiarity with an event and likelihood of the event happening in the future seemed to have no effect on the amount of episodic detail generated by participants. This result differs from Szpunar and McDermott (2008) and DeVito et al. (2012).

One complication of comparing these studies is that they used different methodological approaches. Anderson (2012) used the same events as cues for all participants whereas Szpunar and McDermott (2008) and DeVito (2012) used settings as cues that participants selected from a list according to familiarity. In addition, Anderson introduced a new category of event/cues: the unfamiliar but likely events. Taking a young adult perspective as Anderson (2012) did, events like “Move into my first home” or “Meet with a lawyer” may be likely, but also unfamiliar.

However, what people understand as likely or familiar also relies on their previous experience and future goals. Hence, we believe it is essential to consider evaluations made by participants about the events, as Szpunar and McDermott (2008) and DeVito (2012) did. Finally, to fully address the influences of likelihood and familiarity, we crossed the two variables. Examples of familiar but unlikely events include events such as "Play tag" or "Go to a high school science class."

1.4 Assessing Episodic Future Thinking

For studying EFT, two measures stand out as the most used: the Autobiographical Interview (AI) (Levine et al., 2002) and self-rated phenomenological scores (D'Argembeau & Van der Linden, 2006). Miloyan and McFarlane (2019) reviewed assessment instruments to measure episodic foresight, including EFT. They classified measures into content and generation measures. AI and phenomenological scores are both considered content measures because they address the inherent characteristics of the event itself rather than quantify the participant's production of events. Miloyan and McFarlane (2019) considers AI to be a content examination measure in which external observers rate the participant's verbal responses. Phenomenological scores, on the other hand, are considered a content phenomenology measure because participants rate their own mental experience.

As expected, each measure produces different variables. AI scores are expressed as the number of details segmented and extracted from the participants' verbal description of a future event simulation. The number of details is distributed across categories, firstly grouped as internal or external detail, and then within seven subcategories (event, perceptual, place, time, emotion/thought, semantic, repetition, other). Phenomenological scores are produced by participants' evaluation of their own mental experience during simulation. The ratings refer to participants' overall mental representation of visual and sensory details, as well as clarity of context, and time.

There are advantages and disadvantages associated with each measure. For AI scoring, researchers must implement several checks, such as basing the scoring on agreement across multiple judges (Miloyan & McFarlane, 2019). However, scores can be as affected by participants' wordiness as by a scorer's subjectivity; after all, the detail segmentation is arbitrary (Levine et al., 2005). Phenomenological scores, on the other hand, can be challenging because the measure is subjective, and participants may interpret the scales differently (Miloyan & McFarlane, 2019).

One common procedure for content measurement consists of providing participants with cues to induce simulations. The cues that researchers use reflect the aims of the study. For example, participants can be asked to recall a specific autobiographical event and then simulate it in a future scenario (Levine et al., 2002). Alternatively, researchers can provide the same cues for all participants (Anderson, 2012; D'Argembeau & Van Der Linden, 2004).

### 1.5 Current study

We investigated how familiarity and likelihood with events shape how people simulate future events. To do this, we evaluated the individual and combined effects of familiarity and likelihood. We predicted that we would replicate findings of previous studies showing that greater familiarity with an event improves simulations in the sense that the participants will experience a clearer representation of the event, as well as offer more details about it (de Vito et al., 2012; Szpunar & McDermott, 2008). Additionally, we expected to find that likelihood interacts with familiarity to improve simulations by making them clearer and more detailed.

To study the contributions of familiarity and likelihood we used an approach that is sensitive to individual participants' past experiences and potential futures. We conducted three studies to create sets of events tailored to each participant. In Study 1, we collected four pools of events: those that are familiar and likely; familiar and unlikely; unfamiliar and likely, and unfamiliar and unlikely. In Study 2, we refined the pool from Study 1 by collecting participants' ratings of familiarity and likelihood, as well as expected future frequency, emotional valence, rumination (how often they have thought about an event happening in their future), and personal experience. Finally, in Study 3, participants simulated future events that were selected using their own ratings. We used both phenomenological scores and Autobiographical Interview scoring of simulations to obtain self-rated and observer-rated results.

In conclusion, this study's primary innovation lies in carefully addressing the separate and combined effects of familiarity and likelihood as individual variables. In addition, we designed a novel experimental approach that includes a customized set of cues for each participant based on their simulations and descriptions of future events.

# Chapter 2

## Study 1- Event generation

### 2.1 Introduction

The primary purpose of this research is to examine the independent and combined effects of familiarity and likelihood on the simulation of future events. We used a factorial design in which each event belonged to one of four conditions: (1) high likelihood and high familiarity; (2) high likelihood and low familiarity, (3) low likelihood and high familiarity; and (4) low likelihood and low familiarity. Because we used a novel design, we created a pool of events distributed across those categories. Another novel characteristic of our study is that the stimuli were tailored to each individual participant in Study 3. We therefore needed a large pool of events from which the final sets of events could be selected.

An important consideration is that we began data collection just after the onset of the COVID-19 pandemic. We are aware that this unusual situation might influence participants' responses. However, we did not want to bias them one way or another, so we did not mention the COVID-19 pandemic in the instructions. We paid special attention to events that could refer to COVID-19 onset. We also used a 10-year future window in all instructions to minimize the influence of the unusual present conditions.

### 2.2 Methods

#### 2.2.1 Participants

Twenty-seven participants were recruited for an online study through Amazon Mechanical Turk (MTurk) in exchange for a one-hour payment. Three participants were excluded from analyses because they did not follow the instructions. Another participant was excluded because we suspected they did not belong to the sociodemographic group selected for this study. We applied constraints of age and region through MTurk. Participants ranged from 18 - 25 years old, were residents of Canada or the United States, and were English speakers.

2.2.2 Materials and design

An online survey was designed to collect events that fell into one of the following categories: (1) high likelihood and high familiarity; (2) high likelihood and low familiarity, (3) low likelihood and high familiarity; and (4) low likelihood and low familiarity. We asked participants to generate up to 15 events of each type. The survey was designed using survey hosting platform, Qualtrics Software, version July 2020 of Qualtrics, Copyright © 2020 Qualtrics (Appendix A). Security measures for the survey were necessary for fraud and bot detection because an external service recruited participants. We included a mandatory reCAPTCHA verification, constraints to avoid re-submissions, and answer options in the form of text entry boxes.

The survey began with a letter of information (Appendix B) and a letter of consent. Once participants expressed consent, the task instructions appeared. Instructions included a description of what counts as an event, and then familiarity and likelihood were explained. After participants entered events into the four text boxes, the survey ended with a debriefing form (Appendix C).

As appeared in the instructions, an event is a segment of time at a given location conceived by an observer to have a beginning and an end (Zacks & Tversky, 2001). In addition to locations (a place, a restaurant, my home) and segments of time, events also involve actions (go, eat, sleep), agents (people, I, a friend) and scripts (order of steps, what you might do first, what you might do next, and so on).

Familiarity concerns how much participants know about an event, either because they have directly experienced something similar in the past, or because they have learned about it from other sources, such as through conversations, books, movies, videos, and so on. On the other hand, likelihood concerns participants' certainty that an event might happen to them in the future, *when* in the future was defined as occurring during the next ten years.

We instructed participants in terms of what to consider as high or low familiarity, and high or low likelihood, events. Whereas high familiarity reflects having quite a bit of knowledge, low familiarity would mean having limited or no knowledge about the event. In the case of likelihood, a highly likely event means that participants believe it is highly probable that the event will happen to them in the next ten years, whereas a low likelihood event is the opposite. The survey also provided participants with specific examples of possible responses. Each category appeared on a single page. The survey took approximately 30 minutes to complete.

### 2.2.3 Procedure

Study protocols were approved by the University of Western Ontario's Non-Medical Research Ethics Board (WREM) (Appendix D). The survey was distributed using an anonymous link generated by Qualtrics Software, version July 2020 of Qualtrics, Copyright © 2020 Qualtrics. Participants accessed the link through their MTurk worker profile.

After accessing the survey, participants were asked to confirm that they had read and understood the letter of information, and whether they explicitly expressed consent to participate. Only after consenting did they begin the survey. None of the questions were mandatory, except for the one referring to consent to participation.

## 2.3 Analyses and results

### 2.3.1 Participant exclusion

Three participants' responses were excluded because they did not follow the instructions for generating events. All of their responses were limited to general scenarios, such as "family bad moments." Overall settings are not the kind of cues we aimed to use as a part of the final pool, so we excluded these responses from analyses. One other participant's responses were excluded because we suspected that they were not in the established age range. Several responses such as "my granddaughter will start dating" and "my daughter will get a job" led to that conclusion.

2.3.2 Data processing

Each participant generated 15 responses in each category. There was a total of 1380 responses from 23 participants. Exclusion analyses were necessary to rule out responses according to a set of guidelines created for this aim. For analyses, we used four judges' criteria.

*Exclusion criteria*

We excluded responses that were "not events" because they did not reference a specific action in a hypothetical time frame. We identified three categories of exclusion: states, non-specific events, and negative occurrences (Table 1).

*Table 1. Exclusion criteria to exclude non-events from the survey responses in Study 1.*

| Categories of exclusion | Meaning | Examples |
|---|---|---|
| States<br>(8 responses excluded) | Particular states that are not tied to one event | *Be happy*<br>*I will get used to being gendered correctly* |
| Non-specific responses<br>(23 responses excluded) | Events where the temporal-spatial limits are nonspecific | *Becoming a popstar*<br>*Live in a messy and unclean environment* |
| Negative happenings<br>(3 responses excluded) | Responses for which it is unclear what the events are because the participant | *I will not work as an intern.* |

| | | |
|---|---|---|
| | mentioned only what will not happen | |

*Note.* Examples are participants' responses to the survey.

Using four judges' criteria, we also excluded several events that could be controversial to simulate, like "Vote Republican" or "Killing someone"; overly specific to a single participant, like "Giving my dad's sisters my phone number," or highly emotionally charged like "Witnessing someone die." As we mentioned before, we were concerned about potential influences of COVID-19 on responses. From 345 responses, only one ("Get the COVID vaccine") referred to this context. Notably, it was produced for the low familiarity-low likelihood category. This specific response was excluded, but overall, results suggested that participants did not explicitly consider the current pandemic as an element of their 10-year future.

*Rephrasing and merging rules*

Because participants freely generated responses, they often used different phrasing to refer to the same or very similar events. It was necessary, then, to identify overlapping responses. We created the following set of merging and or rephrasing rules to maximize stability in the analysis and replicability of the study (Table 2). In the same sense, we also created rules for when similar events should not be merged (Table 3).

*Table 2. Rules for merging or rephrasing events from the survey responses in Study 1.*

| Rules for merging or rephrase | Example | Merge or rephrase as |
|---|---|---|
| 1. When the action appeared with the *-ing* suffix, it was merged or rephrased in the present tense form. | *Going to the movies* | *Go to the movies* |

| | | |
|---|---|---|
| 2. When changes in the action verb do not involve differences in the event, it was rephrased in the simplest way. | *Catch back up on the mainstream videogame scene* | *Play videogames* |
| 3. When interchangeable items were used, they were merged into the one that expressed a broader concept. | *Buy a new laptop* | *Buy a new computer* |
| 4. When possessive pronouns were used to describe an object, it was merged or rephrased by using the article a/an | *Ride my bike* | *Ride a bike* |
| 5. When an anticipated action was involved, it was rephrased using only the present action. | *Return to college* (presumes specific personal experience with the event in the past) | *Go to college* |
| 6. When the motivation for the action is implicit in the location characteristics, it was merged or rephrased omitting the motive. | *Go to the dentist to fill a cavity.* This rule does not apply to specific cases when the event refers to an uncommon or irregular visit like *Go to the obstetrician to check if I am pregnant.* | *Go to the dentist* |
| 7. When the event included adjectives that refer to a | *Take my nice cameras out for pretty pictures around town* | *Take pictures around town* |

| | | |
|---|---|---|
| personal point of view, the adjective was omitted, and the event was merged with a similar one. | | |
| 8. When a response did not describe an event, but it was similar to an event mentioned by another participant, it was merged with it. | *Become close with a church community* | *Go to church* |
| 9. When it was unclear if the event refers to the participant as an actor because the response used the passive voice, it was merged or rephrased as an action made by the person who is describing the event. | *Have solar panels installed* | *Install solar panels* |
| 10. When there is greater than one event that appeared as one, the main event or goal event remained as the event. | *Go on a road trip to visit my family* | *Visit my family* |

*Note.* Examples are participants' responses to the survey.

*Table 3. Rules for not merging similar events from the survey responses in Study 1.*

| Rules | Examples |
|---|---|
| 1. If it was the same event, but the actors changed | *Have dinner*<br>*Have dinner with my family* |

| | | |
|---|---|---|
| 2. | If a specific item was mentioned that could involve differences in particular actions. | *Go shopping for clothes*<br>*Go shopping for groceries*<br>*Go shopping groceries for a holiday dinner'* |
| 3. | If the adjective "favourite" was used to describe the action because the participant was referring to a more constrained action | *Watch a movie*<br>*Watch my favourite movie* |
| 4. | If it was suspected that specific steps should be taken in the event | *Make dinner*<br>*Make dinner from scratch* |
| 5. | If a more extensive event may involve others, but reversibility cannot be assumed. | *Go to the gym* includes the event *Do exercises*. However, these two events should not be merged because *Do exercises* does not necessarily involve *the gym* as a location. |
| 6. | If "alone" or "by myself" was used. These events may involve special steps for some participants. | *Travel by myself*<br>*Travel to Europe* |

*Note.* Examples are participants' responses to the survey.

Another concern was how to enhance the scope of the event pool. For that, we conducted a final analysis of the events, this time to make the event as broad as possible and less culturally biased. The following rules were applied (Table 4):

*Table 4. Rules to enhance the scope enhance the scope of the event pool from the survey responses in Study 1.*

| Element | Rule | Rephrase |
|---|---|---|
| Locations' name | Fast food locations reference events like *Have dinner at McDonald's* or *Have dinner at Subway.* | *Have dinner at a fast-food restaurant* |
| | The same rule applies for shopping at specific places like "Walmart" or "Costco." | *Go shopping for supplies.* |
| Religion | When a specific religious holiday was mentioned *Christmas dinner with my family* | *Holiday dinner with my family* |
| Romantic partners | When "boyfriend," "girlfriend," or "fiancée" was used, | "Romantic partner." |
| | In the case of "wife" or "husband" | "Spouse." |
| Family members | When words like "mom-mother", "dad-father", "mom and dad-parents", "sister/brother-sibling", "daughter/son-kid" were used | In a broader manner: parent(s), sibling(s), kid(s) |
| Pets | When a specific pet was mentioned in an event that could involve any pet, such as *Feed my cat* or *Take my dog to the veterinarian.* | *Feed my pet* |

| | | |
|---|---|---|
| | This rule did not apply to actions like *Take my dog for a walk*, which is primarily associated with dogs. | |
| Places to live | When "apartment," "house," "place to live" was used | "Home." |

*Note.* Examples are participants' responses to the survey.

2.4 Conclusion

After processing 345 responses, a final set of 187 events was created using the rules described above. The 187 events were balanced approximately across categories: 45 high familiarity - high likelihood events, 44 high familiarity - low likelihood events, 45 low familiarity - high likelihood events, and 53 low familiarity - low likelihood events (See Appendix E for the complete list). These events served as the basis for the subsequent two studies.

# Chapter 3

## Study 2 -Events evaluation

### 3.1 Introduction

This research aimed to identify combined and individual effects of familiarity and likelihood on the simulation of future events. The quality of a simulation can be measured using participants' ratings of phenomenological experience, and the number of details produced during the simulation verbal report. We expected that high levels of familiarity and likelihood would enhance simulation quality. However, other variables could also influence simulation quality, and we sought to identify and control them.

Emotional valence, amount of personal experience, estimated future frequency, and amount of rumination were measured using participants' ratings because of their potential impact on the results. We also collected ratings of familiarity and likelihood. We used the Study 2 results to develop a well-controlled set of events as the basis for individually tailored materials for Study 3.

#### 3.1.1 Emotional valence

People generally think about the future positively (Newby-Clark & Ross, 2003), and representations of future positive events have been associated with a greater feeling of phenomenological pre-experiencing than negative events (D'Argembeau & Van Der Linden, 2004). In Study 1, we used our intuition to remove highly emotionally charged events. In Study 2, we conducted a more detailed analysis by collecting participants ratings on emotional valence.

#### 3.1.2 Personal experience

We measured how often an event has been personally experienced in the past. Familiarity with an event concerns an individual's knowledge that has been learned from difference sources of information. Previous personal experience is a component of what underlies familiarity. Simulation of future events is more efficient if a combination of episodic and semantic knowledge is used, rather than only episodic information that may come from less frequently experienced events (Anderson, 2012; Szpunar, 2010). Therefore, in addition to overall familiarity, we collected participants' ratings of personal real-world experience.

3.1.3 Future frequency

We asked participants to rate how often they think that the event might occur in their future. Renoult et al., (2016) found that events that participants expect to be experienced frequently may lack specific episodic details.

3.1.4 Rumination

Another factor that could influence simulation is rumination, or how often someone previously has thought about a potential future event. We suspected that this could be part of the mechanism underlying how EFT and current behaviour are linked. Theories of motivated memory suggest that cognition is driven by goals (Conway, 2005). We therefore hypothesized that the degree to which people have thought about likely future events will be correlated with their estimates of likelihood, and both will lead to more detailed simulation.

From Study 1, we obtained a list of 187 events to be rated (Appendix E) in the present study. We divided the pool into 4 lists, each of which had a balanced number of events within each familiarity by likelihood condition. We estimated that rating 25% of the events (one list) would take approximately 1 hour. Each participant rated only one list.

## 3.2 Methods

### 3.2.1 Participants

Eighty-one participants were recruited for an online study through SONA in exchange for one-credit per hour. Participants were all Western University undergraduate students. Participants' mean age was 18 years, with 68% identifying as female. Lists were distributed to four sub-groups of 20, 21, 21, and 19 participants, respectively. No responses were excluded from the analyses.

### 3.2.2 Materials and design

An online survey was designed to collect ratings of familiarity, likelihood, emotional valence, personal experience, rumination, and future frequency for each event. The survey was designed using Qualtrics Software, version July 2020 of Qualtrics, Copyright © 2020 Qualtrics (Appendix F).

The survey began with a letter of information (Appendix B), and a letter of consent. Once participants expressed their consent, they provided sociodemographic information including age, level of education, and whether they were native English speakers. Instructions included a description of what counts as an event, and then familiarity and likelihood were explained. Instructions were like those in Study 1, although this time familiarity and likelihood were rated using a 7-point Likert scale. The remaining ratings involved answering specific questions about the event.

The events then appeared, one by one, each followed by six ratings. The first two asked participants to rate the event's familiarity and likelihood. Next, participants rated future frequency in terms of how often they believe this event will happen in their future by choosing "Never," "Once," "A few times," or "Often." The remaining ratings used a 7-point Likert scale.

For emotional valence, participants rated how negative/positive their emotions would be if the event happened in their future, on a scale from "Very negative" to "Very positive." For rumination, they were asked how often they previously have thought about this event happening in their future, on a scale from "Never" to "Very often." Finally, for personal experience, participants were asked to rate how often they have been personally involved in the event, on a scale from "Never" to "Many times".

We distributed 187 events across four different lists of 45, 48, 48, and 46 events. We based the distribution on two criteria: a balanced number of events within each of the four categories, and events within the same categories must be as different as possible. Event order was randomized for each participant to control for order effects.

3.2.3 Procedure

Study protocols were approved by the University of Western Ontario's Non-Medical Research Ethics Board (WREM) (Appendix D). The survey was distributed using an anonymous link generated by Qualtrics Software, version July 2020 of Qualtrics, Copyright © 2020 Qualtrics. Participants accessed the link through their SONA profile.

3.3 Analyses and results

3.3.1 Familiarity and likelihood

Events were grouped within each of the four categories according to familiarity and likelihood ratings. Mean Familiarity ($M_{\text{Familiarity}}$) and Likelihood ($M_{\text{Likelihood}}$) ratings were classified as "high" or "low" according to their values with respect to the variable's mean across all events ($M_{\text{Overall\_variable}}$). Values greater than or equal to the overall mean were labelled as "high", and values below were labelled as "low". Seventy-two events were classified as high familiarity-high likelihood, 71 as low familiarity-low likelihood, 22 as high familiarity-low likelihood, and 22 as low familiarity-low likelihood. Table 5 and 6 shows the descriptive statistics of the total pool of events.

*Table 5. Descriptive statistics (N, Mean, Standard Deviation, Minimum, and Maximum values) of rated events in Study 2.*

| Variable | N | *M* | *SD* | Min | Max |
|---|---|---|---|---|---|
| Familiarity | 187 | 3.90 | 1.63 | 1.35 | 6.89 |
| Likelihood | 187 | 4.07 | 1.85 | 1.00 | 7.00 |
| Emotional valence | 187 | 4.55 | 1.53 | 1.00 | 6.86 |
| Personal experience | 187 | 3.18 | 1.95 | 1.00 | 6.95 |
| Future frequency | 187 | 2.35 | 0.87 | 1.00 | 3.95 |
| Rumination | 187 | 3.18 | 1.20 | 1.10 | 6.43 |

*Table 6. Descriptive statistics (N, Mean, Standard Deviation, and range) of rated events in Study 2 divided by categories of familiarity and likelihood.*

| Category | | Familiarity | | | Likelihood | | |
|---|---|---|---|---|---|---|---|
| | *N* | *M* | *SD* | Range | *M* | *SD* | Range |
| High familiarity-high likelihood | 72 | 5.39 | 0.97 | 3.16 | 5.92 | 0.76 | 2.68 |
| Low familiarity-low likelihood | 71 | 2.33 | 0.59 | 2.22 | 2.37 | 0.93 | 2.90 |
| High familiarity-low likelihood | 22 | 5.97 | 0.96 | 2.86 | 2.66 | 0.84 | 2.95 |
| Low familiarity-high likelihood | 22 | 2.99 | 0.48 | 1.91 | 4.87 | 0.78 | 2.89 |

3.3.2 Selection criteria

After creating four groups of events, we selected the best candidates for the final pool. The analyses consisted of a set of selection criteria based on the literature and our research aims.

*Difference between familiarity and likelihood ratings*

Once events were classified into the categories, we selected the best events by calculating the difference between familiarity and likelihood ratings. For symmetrical categories (high familiarity and likelihood, and low familiarity and likelihood), we selected events with the smallest difference, so ratings of familiarity and likelihood were as similar as possible. What motivated us to balance the difference was to homogenize the participant's interpretation of the scale. We did the opposite for asymmetrical categories (high familiarity-low likelihood, low familiarity-high likelihood) because, in this case, we aimed for a larger difference between familiarity and likelihood, so that the effect of the variable is more noticeable.

*Control variables*

We attempted to control the range, mean (*M*), and standard deviation (*SD*) of familiarity and likelihood across categories of the same level (e.g., high familiarity should be similarly high for both levels of likelihood). We aimed to control what is considered as "high" or "low" across symmetrical and asymmetrical categories.

Mean, standard deviation and range of emotional valence, personal experience, future frequency, and rumination were also controlled across groups. Personal experience scores were expected to be correlated with familiarity. Similarly, rumination and future frequency scores were expected to be somewhat correlated with likelihood. However, extreme values were avoided. In the case of emotional valence, we selected events closer to mean values to avoid emotionally charged events. Balancing all criteria was challenging. In cases where it was impossible to balance all the variables, we prioritized familiarity and likelihood because these were our primary variables of interest.

*Event content analysis*

We analyzed the events according to content diversity, meaning that we selected only one from a group of similar events, and we made similarity judgements based on the event's characteristics, such as action or places. For example, some events were quite similar, like "Go to a Disney theme park for a day" and "Visit a tourist attraction". In this case, the second event was selected over the first one due to selection criteria (i.e., balancing the control variables). The other criterion that we considered was episodic richness. This refers to the ceiling on the number of details that we expected participants to be able to generate due to the events' intrinsic characteristics. For example, we removed the event "Declare my belongings at customs" because of this criterion.

Table 7 shows the descriptive statistics for the final pool of 43 events that were used in Study 3 after applying the selection criteria. The final set of events and accompanying descriptive data appear in Appendix G.

*Table 7. Means for the events selected for Study 3. Events are distributed by categories: high familiarity-high likelihood (H-F/ H-L), low familiarity-low likelihood (L-F/L-L), high familiarity-low likelihood (H-F/L-L), and low familiarity-high likelihood(L-F/H-L).*

| Variable | N | Familiarity | Likelihood | Difference | Emotional valence | Personal experience | Future frequency | Rumination |
|---|---|---|---|---|---|---|---|---|
| H-F/ H-L | 11 | 5.66 | 6.06 | 0.40 | 5.91 | 5.56 | 3.27 | 4.51 |
| L-F/L-L | 11 | 2.29 | 1.09 | 0.20 | 5.28 | 1.41 | 1.49 | 2.34 |
| H-F/L-L | 11 | 5.35 | 2.20 | 3.15 | 4.09 | 4.54 | 1.58 | 1.94 |
| L-F/H-L | 10 | 2.68 | 5.34 | 2.67 | 4.95 | 1.84 | 2.49 | 3.80 |

3.3.2 Relationships between variables

We explored the relationships between variables through correlation analyses. For these analyses, we used the mean scores of the 187 evaluated events. Spearman correlations were performed to assess whether the variables were correlated and are reported in Table 8. All correlations were significant ($p < .01$) and positive, from medium to large strength.

*Table 8. Correlation matrix of familiarity, likelihood, emotional valence, personal experience, future frequency, and rumination.*

| Variables | Familiarity | Likelihood | Emotional valence | Personal experience | Future frequency | Rumination |
|---|---|---|---|---|---|---|
| Familiarity | _ | | | | | |
| Likelihood | 0.71* | _ | | | | |
| Emotional valence | 0.44* | 0.52* | _ | | | |
| Personal experience | 0.96* | 0.70* | 0.42* | _ | | |
| Future frequency | 0.75* | 0.95* | 0.48* | 0.78* | _ | |
| Rumination | 0.51* | 0.82* | 0.61* | 0.46* | 0.74* | _ |

* $p < .001$

The very strong correlation ($r = 0.96$, $p < .001$) between familiarity and personal experience suggests that people rate events that they have a greater direct autobiographical experience with as more familiar. This aligns with previous results about the important role of autobiographical episodic memory in EFT.

As predicted, a strong correlation was also found between likelihood and rumination ($r = 0.82$, $p < 0.001$). We hypothesized that the likelihood of an event could cause repeated thoughts about a type of event, which might then be reflected in an enhancement of simulation quality.

This could potentially support a likelihood effect in Study 3. We investigate this hypothesis further in the next section.

3.3.3 Rumination-likelihood mechanism

We paid special attention to the relationship between rumination and likelihood, seeking to explore underlying EFT mechanisms. We expected the likelihood of an event occurring in a person's autobiographical future to be linked to recurring past simulations of the event. To test whether the relationship between likelihood and rumination is due to a mediator effect of familiarity, a mediation analysis was conducted with likelihood as predictor, familiarity as mediator, and rumination as outcome. Importantly, familiarity was significantly related to both rumination and likelihood, and the literature on EFT strongly supports an effect of familiarity on simulations (See Chapter 1).

We found a strong correlation between likelihood and rumination. In addition, familiarity correlated with likelihood ($r = 0.71$, $p < .001$), and with rumination ($r = 0.51$, $p < .001$). The mediation analysis results appear in Figure 1 and in Table 9.

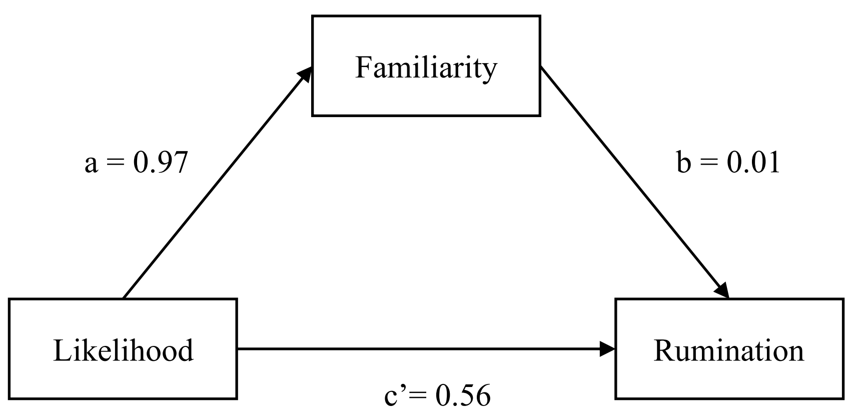


*Figure 1. Mediation analysis with likelihood as predictor, familiarity as mediator, and rumination as outcome*

*Table 9. Mediation analysis results with likelihood as predictor, familiarity as mediator, and rumination as outcome.*

| Effect | Label | Estimate | Z |
|---|---|---|---|
| Indirect | a × b | -0.04 | -1.81 |
| Direct | c | 0.48 | 14.78* |
| Total | c + a × b | 0.44 | 18.71* |

* $p < .001$

Results revealed a non-significant indirect or mediated effect of familiarity on the relationship between likelihood and rumination ($p = 0.932$). The direct effect of likelihood on rumination was significant ($p < .001$), as was the total effect ($p < .001$). The total effect included the three variables of the model, however this pattern of a significant result on the total model, but no indirect effect, could be due to a strong relationship between the independent variable likelihood and the outcome rumination, regardless of a possible familiarity mediation.

In conclusion, it seems that the relationship between likelihood and rumination is relatively independent from familiarity. But mediation analysis provides only preliminary nonexperimental evidence to evaluate whether the proposed causal model is plausible, so we conducted further analyses to examine causality.

Causality between likelihood and familiarity could not be assumed because the data come from a nonexperimental design. We used propensity score matching (PSM) because of its potential to offer an alternative estimation procedure for mediation analysis with alternative assumptions from those of standard mediation analysis (Stuart et al., 2011). PSM creates a set of participants for treatment and control groups. A matched set consists of at least one participant in the treatment group and one in the control group with similar propensity scores. The goal is to approximate a random experiment, eliminating many of the problems that come with observational data analysis. Familiarity, future frequency, and emotional valence were included as control variables because they were significantly correlated with rumination and likelihood. However, personal experience was not included because we decided that its very high correlation with familiarity would only reduce the model's degrees of freedom.

The PSM model (Table 10) showed a significant ($p < .05$) treatment effect among the control and treated sample created by the test. There is evidence that when familiarity, emotional valence, and future frequency are controlled, the likelihood of an event occurring in the future causes recurring thoughts about that event.

*Table 10. Propensity scores matching (PSM) simulation modeling of likelihood causing rumination. The model controlled for familiarity, emotional valence, and future frequency.*

| Variable | Sample | Treated | Controls | t-stat |
|---|---|---|---|---|
| Rumination | Unmatched | 4.03 | 2.32 | 13.70* |
| | ATT[a] | 4.03 | 2.70 | 2.40** |

[a]Mean treatment effect among treated

*$p < .01$, $p$** <0.5

We simulated two additional PSM similar models to test our model accuracy (Appendix H). To seek reciprocal causation between rumination and likelihood, one model included rumination as independent variable, and likelihood as outcome. Control variables were the same as the original model. This model showed a non-significant treatment effect ($p = .2713$), so we ruled out reciprocity.

The other tested model included familiarity as independent variable and likelihood as outcome. Control variables were the same as the original model, but also including rumination. This model showed a non-significant treatment effect ($p$ = .3747).

There is evidence that when familiarity, emotional valence, and future frequency are controlled, the likelihood of an event occurring in the future causes recurring thoughts about that event. Ruminations about the future could be an important part of linking EFT and behaviour. Importantly, participants seem to be aware of their thinking about the future, including not only its contents, but also in terms of frequency.

From our study, we cannot specify whether ruminations about the event were spontaneous (Berntsen & Jacobsen, 2008), or driven by specific cues. Future oriented repeated thoughts align with the SMS principle of a goal-driven cognition.

### 3.4 Conclusions

We collected ratings of familiarity, likelihood, emotional valence, personal experience, future frequency, and rumination for 187 events. After applying a set of selection criteria, we constructed a balanced pool of 43 events that were used as stimuli in Study 3.

The data also allowed us to investigate how the variables are related. All variables were significantly positively correlated, which supports the need to control their possible effects on future event simulation. Understanding the effects of control variables helped us to isolate the effects of familiarity and likelihood.

By modeling the causal relationship between probability and rumination, we sought to investigate possible mechanisms of likelihood. We found evidence that people think more often about events that are likely to be relevant in their future. This could be a feasible mechanism to explain how likelihood impacts behaviour.

# Chapter 4

## Study 3- Experiment

### 4.1 Introduction

We designed a customized approach that involved two experimental sessions: the first for collecting participants' ratings of the events (as in Study 2), and the second for collecting participants' verbal reports and phenomenological ratings of their simulations. We evaluated EFT using two sets of measures: phenomenological self-ratings of participants' mental simulations (D'Argembeau & Van Der Linden, 2004), and measures derived using the AI (Levine et al., 2002) scoring procedures. These are the most used measures in EFT studies, and they provide complementary perspectives when studying how people think about their future. Whereas AI uses an external scoring system, the phenomenological approach uses self-report.

#### 4.1.1 Phenomenological scores

We expected that familiarity and likelihood would influence the phenomenological quality of the simulation. Specifically, we expected that the simulation of events that are more familiar and likely will be experienced as including more visual and sensory details and higher clarity of context and time of the day. We also expected that the independent variables would interact to enhance the simulation phenomenological quality due to likelihood effect for both levels of familiarity.

#### 4.1.2 Autobiographical interview

We expected that familiarity and likelihood would influence the number of internal details during the narration of the simulation. Specifically, we expected that the simulation of events that are more familiar and likely will include a greater number of internal details. We anticipated the opposite result with external details because we expected that the simulation of events that are more familiar and likely will include a lower number of external details. We also expected both independent variables to interact to increase the number of internal details, and decrease the number of external details used, due to an effect of likelihood for levels of familiarity.

4.2 Methods

4.2.1 Participants

Forty-four participants were recruited through SONA for a two-part online study in exchange for one-credit per hour. Eight participants were excluded from the analyses because they did not complete both parts. Two additional participants were excluded because of low audio quality, leaving 34 participants for all analyses. Participants ranged from 18 – 22 years old, 37% identified as female, all were Western University undergraduate students, and 69% were native English speakers, although all were fluent English speakers.

4.2.2 Materials and design

*Selection of the customized set of events*

An online survey was designed to collect ratings of familiarity, likelihood, emotional valence, personal experience, rumination, and future frequency for each event. The survey was designed using Qualtrics Software, version July 2020 of Qualtrics, Copyright © 2020 Qualtrics. Our goal was to select a tailored set of eight cue events for each participant. Each event appeared individually on the screen to minimize participants' direct comparisons among them.

The survey was similar to the one used in Study 2. It started with a letter of information (Appendix B), continued by asking for expressed consent to participation, followed by sociodemographic questions, and task instructions in which participants were informed about what an event is, as well as how to think about event familiarity and likelihood. The instructions and questions were the same as in Study 2; only the list of events changed.

*Phenomenological scores*

Phenomenological scores are derived from the participants' evaluation of their own mental experience during simulation (D'Argembeau & Van der Linden, 2006). Each consists of a seven 7-point Likert scale. Three ratings evaluate a participant's overall mental representation, whereas the other four evaluate the clarity of the context in the simulation. The questions appeared directly after a participant narrated what they "saw" during their mental simulation.

Scores for visual details and other sensory details were obtained through the participants' answers to "Please, rate your overall mental representation according to the following statements. You will rate them from 1 to 7, being 1 *none* and 7 *a lot*." Visual details scores came from ratings for the statement "Your representation of this event involved visual details." Other sensory details scores were obtained by averaging the ratings for the statements "Your representation of this event involved sounds" and "Your representation of this event involved smells or/and tastes".

Spatial context and temporal information scores were obtained through participants' ratings of "About the clarity of the context in your simulation, how do you rate your own mental representation according to the following statements? You must rate them from 1 to 7, 1 being *Vague* and 7 *Clear*." Spatial context scores were the mean ratings for the following three statements: (1) "Your representation for the location where the event takes place is." (2) "The relative spatial arrangement of objects in your representation for the event is." (3) "The relative spatial arrangement of people in your representation for the event is." Temporal information scores corresponded to ratings for the statement "Your representation for the time of day when the event takes place is." In summary, we calculated four phenomenological variables: overall mental representation of visual details, overall mental representation of other sensory details, clarity of the spatial context, and clarity of time of the day.

*Autobiographical interview*

We obtained the AI materials from The Levine Lab (Appendix I). The AI has been used to compare participant narration of past and future possible events using the same event cues, and in studies that focus solely on future events (Anderson, 2012). The AI quantifies elements of autobiographical memory from participants' narration of specific events (Levine et al., 2005). We used the instructions from the Autobiographical interview administration manual (Levine et al., 2005), with modifications due only to the online approach and expectations regarding the current design.

1. I will give you an event as a cue to make you think about a specific event occurring in your future.
2. Once you read the cue, we would like you to take up to 1 minute to simulate the event mentally. You can close your eyes if you prefer it. Try to imagine as much detail as possible. Remember, you must think about that event occurring to you in the future.
3. When you're ready, please narrate out loud your mental simulation, once by describing the event out loud. It is unnecessary to do it correctly or in a particular order; describe the scene as you "saw" it in your mind.
4. The simulation must refer to events of a specific time and place. For example, describing a 3-week vacation would not be enough. However, a particular incident that happens one day during your vacation would be good. Please provide all the details you can about the event.

5. Once you finish your description, I will ask you some questions about your mental simulation.

6. We are going to repeat the same process until we reach 8 events.

7. If you feel uncomfortable simulating a particular event, please let me know, and we can choose a different one.

The AI scoring process involved text segmentation and categorization of each segment. Details were categorized as internal or external. To be internal, a detail must pertain directly to the main event, isolated as defined above. External details are those that are not part of the main event or are factual (often called semantic) information that is not specific to the main event (Levine et al., 2005). Within the internal-external categories, events were also classified according to one of eight categories. There are five categories that could be either internal or external: Event details that describe the unfolding of the story; place details that describe localization in space; time details that refer to temporal information such as life epoch, year, season, date, or time of the day; perceptual details that describe sensory information; and emotion/thought details that refer to the mental state of the participant at the time of the event. The remaining three categories are used to classify external details: semantic details that involve general knowledge or facts; repetitions that refer to unsolicited repetition of a prior information-containing detail; and other details that do not fit into the other categories. We quantified the total details within each category, as well as the total internal and external details.

Each participant's verbal narration of the events was recorded for transcription and further analyses. Given that the data were collected during the COVID-19 pandemic, we interviewed participants through Zoom (using audio only) and conducted the study online. For more detail, see Appendix J for the study protocol.

4.2.3 Procedure

For part one, participants were contacted through email after being recruited through SONA. In the email, participants were instructed to complete an online survey and then wait to be contacted shortly after they had completed it. Once participants filled out the survey. Following the instructions for the AI, we also selected an extra event within each category.

The selection of the custom set was based on the ratings that each individual participant provided for the 43 events. We applied criteria for event selection following the order as it appears in Table 11. First, we needed to ensure that events belonged to one of the four categories, according to the specific participant. We also considered the difference in the ratings between familiarity and likelihood as a membership criterion. Then, we avoided negative events that could be unpleasant to simulate and also extremely positive events. For future frequency, we use Study 2 maximum score mean as threshold (see Table 5). The best events were those below the maximum score because less repeated events were expected to have more associated episodic information (see Study 2 introduction). In rumination, the best events were those with ratings equal to or higher than 2. Considering that events were from low to high likelihood, and rumination is closely related to likelihood, it is understandable events would fall under a wide range of rumination. However, we considered 2 as the lower bound because participants would have at least some previous thoughts about the event. As in the case of rumination and likelihood, personal experience and familiarity are also closely related. In this case, we were also expecting a wide range. However, we avoided extreme personal experience ratings by selecting events with personal experience ratings lower than 6.

*Table 11. Criteria for the selection of a set of personalized events after Part 1 of Study 3*

| Order | Criteria | Criteria to meet |
|---|---|---|
| 1 | Category membership | High: Rating between 6 and 7 |
| | | Low: Rating between 1 and 2 |
| | Difference | Score equal lower than 2 for symmetrical categories |
| | | The highest scores for asymmetrical categories |
| 3 | Emotional charge | Ratings equal or higher than 3 and equal or lower than 6 |
| 4 | Future frequency | Ratings lower than 3.95. |
| 5 | Rumination | Ratings higher than 2 |
| 6 | Personal experience | Ratings lower than 6 |

Participants were contacted through email to arrange a Zoom call for part 2. In this email, we informed participants that the next session would involve audio recording, so they were free to withdraw from the study if they were not comfortable with this, as they were free to withdraw from the study at any point. Participants also received recommendations about technical conditions that they should meet for part 2, including having Zoom installed (the university provides students with this service), having a functional computer microphone, and being able to be located in a quiet place during the session to enhance audio quality.

Once participants accessed the Zoom call, recording did not begin until the participant provided verbal consent for the session to be audio recorded. Participants received all instructions in the Zoom chat, as well as listening to them from the researcher.

Participants received instructions for the simulation of future events, and we used a trial example to familiarize participants with the process. We used the same trial cue "Paint a room" for all participants. After each simulation, participants responded to the phenomenological questions by rating them out loud. The researcher registered the responses at that time.

Participants' audio recorded responses were transcribed. Transcripts with participants' verbal report, in other words, their verbal description of "what they saw" during the simulation, were analyzed using the AI scoring manual (Levine et al, 2005).

Three judges analyzed the transcripts after being trained using the materials provided by The Levine Lab. Each transcript was carefully examined by at least two judges to reach a final scoring agreement. First, three judges individually scored five transcripts. The goal was to ensure that the three judges shared similar approaches and to minimize subjectivity during the scoring. Then, one principal judge scored the remaining transcripts, and each of the other two judges scored half of the remaining transcripts. However, when two judges did not reach consensus, the remaining judge was consulted. Each judge segmented and labelled the transcript as in the example in Appendix K. After the judges reached consensus, the information was entered into a scoresheet (Appendix L).

4.3 Analyses and results

Thirty-four participants simulated eight, two for each of the four categories, for a total of 272 simulated events. Events mean scores according to part one ratings appear in Table 11. Participants scores within each category was calculated as the average of the two events ratings.

*Table 12. Means of the events within each category.*

| | | Variables | | | | | |
|---|---|---|---|---|---|---|---|
| Category | *N* | Familiarity | Likelihood | Emotional valence | Personal experience | Future frequency | Rumination |
| H-F/ H-L | 34 | 6.75 | 6.72 | 6.06 | 5.81 | 3.19 | 4.94 |
| L-F/L-L | 34 | 1.44 | 1.57 | 5.34 | 1.26 | 1.60 | 2.16 |
| H-F/L-L | 34 | 6.72 | 1.71 | 4.59 | 5.88 | 1.72 | 1.76 |
| L-F/H-L | 34 | 1.69 | 6.53 | 4.97 | 1.60 | 2.71 | 4.18 |

As can be seen in Table 12, although small, there were differences between the means within the same subcategory. For example, mean likelihood rating was 1.71 for H-F/L-L and 1.57 for L-F/L-L. We calculated one-way ANOVAs to test whether these differences were nonsignificant. We did not find significant differences between the means within the same subcategory: high familiarity $F(1, 34) = 0.56$, $p = .459$; low familiarity $F(1, 34) = 2.22$, $p = .141$, high likelihood, $F(1, 34) = 0.64$, $p = .425$, and low likelihood $F(1, 34) = 0.83$, $p = .367$. Additionally, we found significant differences between the two levels (high and low) of familiarity and likelihood respectively, familiarity $F(1, 68) = 2308$, $p < .001$, and likelihood $F(1, 68) = 3336$, $p < .001$.

4.3.1 Phenomenological scores

There were four dependent variables: visual details; other sensory details; spatial context; and time. Because each participant provided ratings for two events in each likelihood by familiarity condition, a participants' score for each condition consisted of the mean of those two events.

*Table 13. Phenomenological scores descriptive data across categories*

| | *N* | *M* | *SD* | Min | Max |
|---|---|---|---|---|---|
| Visual details | | | | | |
| - High familiarity-high likelihood | 34 | 6.04 | 0.84 | 4.00 | 7.00 |
| - High familiarity-low likelihood | 34 | 5.94 | 0.69 | 4.50 | 7.00 |
| - Low familiarity-high likelihood | 34 | 5.75 | 1.02 | 3.50 | 7.00 |
| - Low familiarity-low likelihood | 34 | 5.75 | 1.02 | 3.00 | 7.00 |
| Other sensory details | | | | | |
| - High familiarity-high likelihood | 34 | 3.62 | 1.36 | 1.00 | 6.50 |
| - High familiarity-low likelihood | 34 | 3.01 | 1.26 | 1.00 | 5.80 |
| - Low familiarity-high likelihood | 34 | 2.84 | 1.01 | 1.00 | 5.00 |
| - Low familiarity-low likelihood | 34 | 2.96 | 1.04 | 1.00 | 5.50 |
| Spatial context | | | | | |
| - High familiarity-high likelihood | 34 | 5.33 | 0.67 | 3.70 | 6.70 |
| - High familiarity-low likelihood | 34 | 4.89 | 1.00 | 2.80 | 6.70 |
| - Low familiarity-high likelihood | 34 | 4.97 | 0.89 | 3.00 | 6.30 |
| - Low familiarity-low likelihood | 34 | 4.66 | 1.04 | 2.50 | 6.80 |
| Time of the day | | | | | |
| - High familiarity-high likelihood | 34 | 5.52 | 1.42 | 2.00 | 7.00 |
| - High familiarity-low likelihood | 34 | 4.93 | 1.59 | 1.00 | 7.00 |
| - Low familiarity-high likelihood | 34 | 4.65 | 1.22 | 2.50 | 7.00 |
| Low familiarity-low likelihood | 34 | 4.10 | 1.55 | 1.50 | 7.00 |

Each dependent variable was entered into a 2 (high vs. low familiarity) x 2 (high vs. low likelihood) repeated measures ANOVA. All the ANOVA tables appear in Appendix M. For visual details, the interaction was nonsignificant, $F(1, 33) = 0.27$, $p = .610$, $\eta^2p = .008$, as were the main effects of familiarity, $F(1, 33) = 3.38$, $p = .075$, $\eta^2p = .093$, and likelihood, $F(1, 33) = 0.23$, $p = .639$, $\eta^2p = .007$. The quantity of visual details perceived was unaffected by familiarity and likelihood. Descriptive analyses showed that visual details scores had the lowest dispersion among the phenomenological variables (Table 11) and distribution skewness of -0.92 ($SE = 0.21$) suggested the data is highly skewed toward higher scores. Thus, the lack of any significant effects could be due to a ceiling effect. Participants were able to perceive a great number of visual details for all conditions.

For other sensory details, likelihood and familiarity interacted, $F(1, 33) = 4.63$, $p = .039$, $\eta^2p = .123$ (Figure 2). There also were significant main effects of familiarity, $F(1, 33) = 9.66$, $p = .004$, $\eta^2p = .226$, and likelihood $F(1, 33) = 4.43$, $p = .043$, $\eta^2p = .118$.

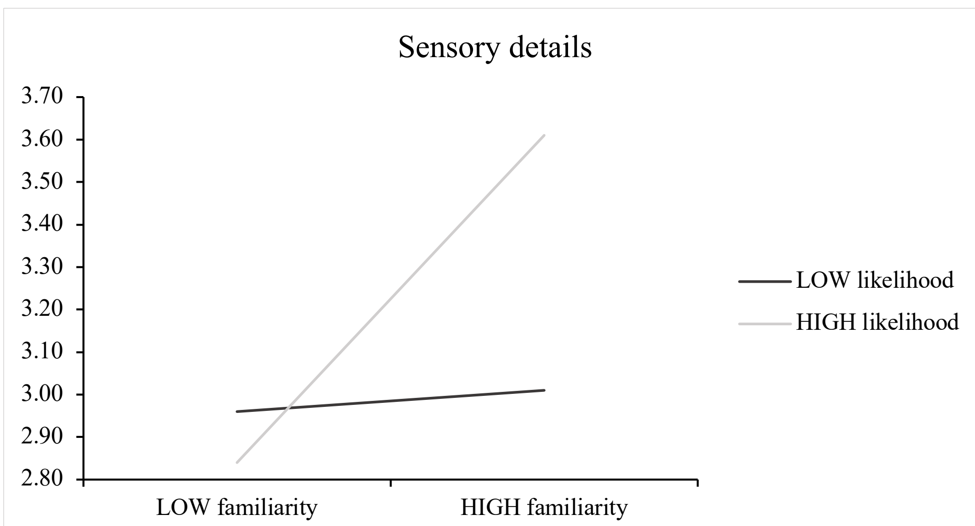


*Figure 2. Estimated marginal means of sensory details (phenomenological scores) across two levels of familiarity (HIGH-LOW) and two levels of likelihood (HIGH-LOW).*

To investigate the significant interaction, we tested the simple main effects of likelihood for both levels of familiarity. The interaction resulted from an effect of likelihood for high familiarity events, $F(1, 58) = 8.781$, $p = .004$, but not for low familiarity events, $F(1, 58) = .364$, $p = .549$.

For spatial context, likelihood and familiarity did not interact, $F(1, 33) = 0.32$, $p = .574$, $\eta^2 p = .010$ (Figure 3). Spatial context ratings were significantly higher for highly likely events, $F(1, 33) = 3.47$, $p = .001$, $\eta^2 p = .095$. There was no main effect of familiarity, $F(1, 33) = 0.32$, $p = .071$, $\eta^2 p = .280$.

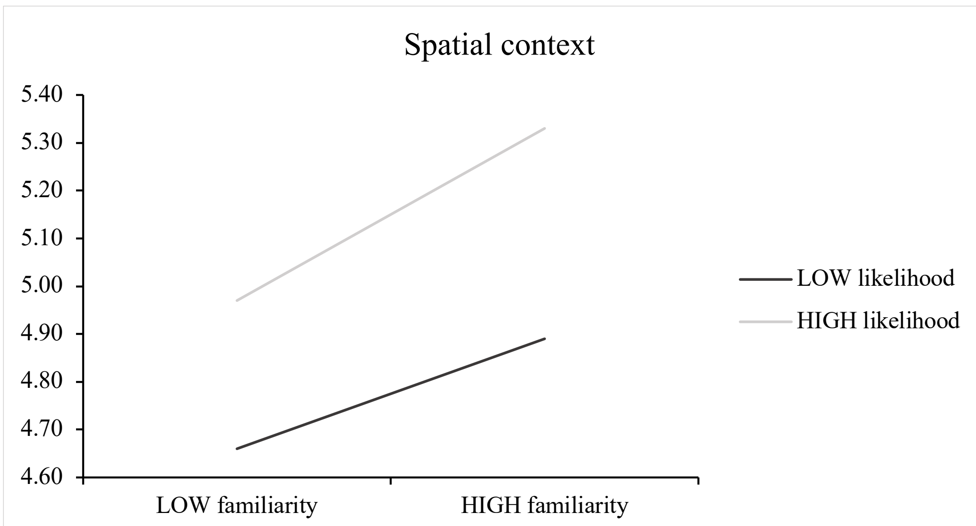


*Figure 3. Estimated marginal means of spatial context (phenomenological scores) across two levels of familiarity (HIGH-LOW) and two levels of likelihood (HIGH-LOW).*

For time of day clarity ratings, the interaction was nonsignificant, $F(1, 33) = 0.01$, $p = .915$, $\eta^2 p = .000$ (Figure 4). Time of day ratings were higher for high than for low familiarity events, $F(1, 33) = 13.23$, $p = .001$, $\eta^2 p = .286$, and higher for high than for low likelihood events, $F(1, 33) = 6.45$, $p = .016$, $\eta^2 p = .163$.

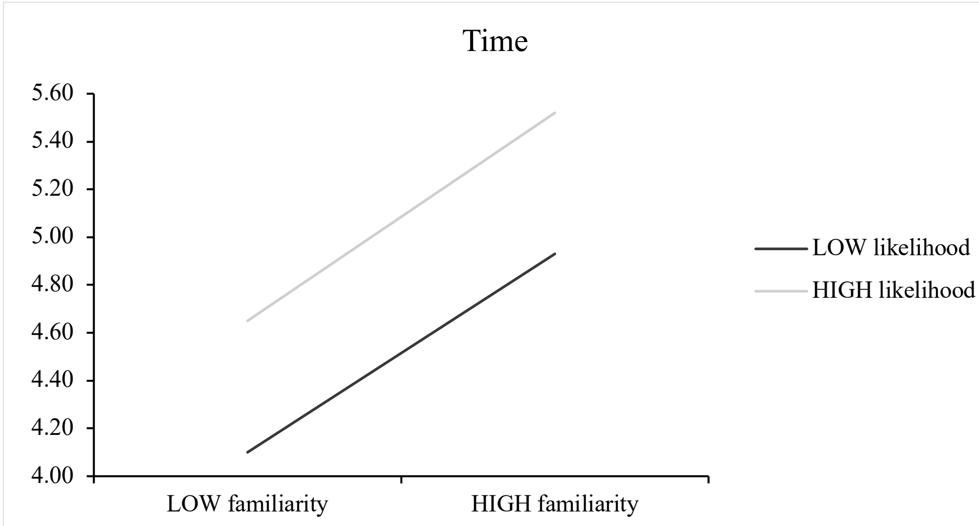


*Figure 4. Estimated marginal means of time of the day (phenomenological scores) across two levels of familiarity (HIGH-LOW) and two levels of likelihood (HIGH-LOW).*

4.3.2 Autobiographical interview scoring.

Verbal descriptions of the mental simulations provided by the participants were recorded, transcribed, and analyzed. Then, when segmenting and classifying the details, the variables were calculated according to the number of details within each classification. Also, two total variables were built from summing internal and external overall details respectively. As with phenomenological scores, participants' responses within each of the familiarity and likelihood combination were averaged.

Shapiro-Wilks's test indicated that the data did not follow a normal distribution ($0.12 < W > 0.89$, $p < .001$). Given that it is difficult to determine normality from a relatively small amount of data, we continued to use analyses of variance. Table 12 shows averaged descriptive data across variable and category.

*Table 14. Autobiographical interview scores descriptive data across categories.*

| Variables | *Internal* | | | *External* | | |
|---|---|---|---|---|---|---|
| | *N* | *M* | *SD* | N | *M* | *SD* |
| Episodic details | | | | | | |
| High familiarity-high likelihood | 34 | 7.19 | 4.39 | 34 | 0.52 | 0.72 |
| High familiarity-low likelihood | 34 | 7.66 | 3.90 | 34 | 0.59 | 1.10 |
| Low familiarity-high likelihood | 34 | 7.31 | 4.62 | 34 | 0.34 | 0.56 |
| Low familiarity-low likelihood | 34 | 7.21 | 4.33 | 34 | 0.57 | 0.94 |
| Place details | | | | | | |
| High familiarity-high likelihood | 34 | 1.25 | 0.93 | 34 | 0.06 | 0.20 |
| High familiarity-low likelihood | 34 | 0.99 | 0.74 | 34 | 0.03 | 0.12 |
| Low familiarity-high likelihood | 34 | 1.34 | 1.01 | 34 | 0.34 | 0.56 |
| Low familiarity-low likelihood | 34 | 1.21 | 0.60 | 34 | 0.02 | 0.09 |
| Time details | | | | | | |
| High familiarity-high likelihood | 34 | 0.74 | 0.81 | 34 | 0.02 | 0.09 |
| High familiarity-low likelihood | 34 | 0.68 | 0.77 | 34 | 0.03 | 0.17 |
| Low familiarity-high likelihood | 34 | 0.57 | 0.66 | 34 | 0.02 | 0.09 |
| Low familiarity-low likelihood | 34 | 0.46 | 0.68 | 34 | 0.02 | 0.09 |
| Perceptual details | | | | | | |
| High familiarity-high likelihood | 34 | 4.19 | 2.68 | 34 | 0.02 | 0.09 |
| High familiarity-low likelihood | 34 | 2.69 | 1.92 | 34 | 0.06 | 0.27 |
| Low familiarity-high likelihood | 34 | 2.85 | 2.43 | 34 | 0.03 | 0.17 |
| Low familiarity-low likelihood | 34 | 3.44 | 2.12 | 34 | 0.15 | 0.54 |
| Emotion/thoughts details | | | | | | |
| High familiarity-high likelihood | 34 | 1.13 | 1.34 | 34 | 0.19 | 0.33 |
| High familiarity-low likelihood | 34 | 1.31 | 1.51 | 34 | 0.28 | 0.48 |
| Low familiarity-high likelihood | 34 | 1.32 | 1.37 | 34 | 0.24 | 0.39 |
| Low familiarity-low likelihood | 34 | 1.10 | 1.20 | 34 | 0.27 | 0.45 |
| Semantic details | | | | | | |
| High familiarity-high likelihood | - | - | - | 34 | 0.72 | 0.83 |
| High familiarity-low likelihood | - | - | - | 34 | 0.63 | 0.85 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Low familiarity-high likelihood | - | - | - | 34 | 0.66 | 0.69 |
| Low familiarity-low likelihood | - | - | - | 34 | 0.60 | 0.85 |
| Repetitions | | | | | | |
| High familiarity-high likelihood | - | - | - | 34 | 0.52 | 0.47 |
| High familiarity-low likelihood | - | - | - | 34 | 0.50 | 0.55 |
| Low familiarity-high likelihood | - | - | - | 34 | 0.46 | 0.50 |
| Low familiarity-low likelihood | - | - | - | 34 | 0.38 | 0.52 |
| Others | | | | | | |
| High familiarity-high likelihood | - | - | - | 34 | 0.28 | 0.46 |
| High familiarity-low likelihood | - | - | - | 34 | 0.29 | 0.49 |
| Low familiarity-high likelihood | - | - | - | 34 | 0.18 | 0.44 |
| Low familiarity-low likelihood | - | - | - | 34 | 0.27 | 0.45 |
| Total details | | | | | | |
| High familiarity-high likelihood | 34 | 14.50 | 6.13 | 34 | 2.31 | 1.75 |
| High familiarity-low likelihood | 34 | 13.32 | 4.43 | 34 | 2.41 | 2.25 |
| Low familiarity-high likelihood | 34 | 13.40 | 5.71 | 34 | 2.25 | 1.76 |
| Low familiarity-low likelihood | 34 | 13.41 | 5.94 | 34 | 2.27 | 2.03 |

*Note:* Data was calculated by averaging the two ratings within the same category

Two by two repeated measures factorial ANOVAs were conducted for each of the AI dependent variables. Only two of them revealed significant results. The ANOVA tables appear in Appendix N.

For perceptual details, likelihood and familiarity interacted, $F(1, 33) = 11.17$, $p = .002$, $\eta^2 p = .002$ (Figure 5). The interaction occurred because there was a significant simple main effect of likelihood for high familiarity events, $F(1, 66) = 9.09$, $p = .004$, but not for low familiarity events $F(1, 66) = 2.86$, $p = .096$, and the effects of likelihood differed in direction. There were nonsignificant main effects of both familiarity, $F(1, 33) = 0.57$, $p = .455$, $\eta^2 p = .017$, and likelihood $F(1, 33) = 2.08$, $p = .159$, $\eta^2 p = .059$.

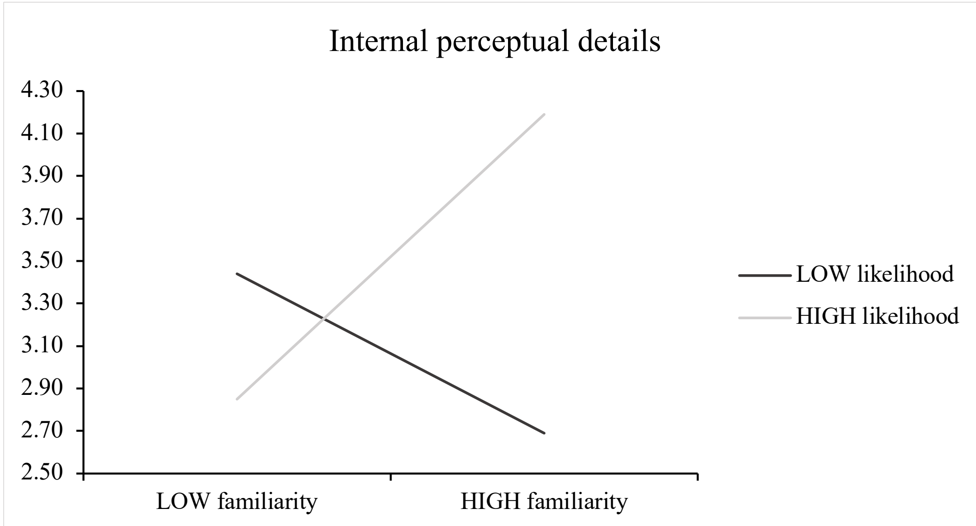


*Figure 5. Estimated marginal means of internal perceptual details (AI) across two levels of familiarity (HIGH-LOW) and two levels of likelihood (HIGH-LOW).*

For external place details, likelihood and familiarity interacted, $F(1, 33) = 8.78$, $p = .006$, $\eta^2p = .210$. Simple main effects analyses showed that the interaction was due to an effect of likelihood for low familiarity events, $F(1, 65) = 18.86$, $p < .001$, but not for high familiarity events, $F(1, 65) = 0.16$, $p = .688$ (see Figure 6). There also were significant main effects of familiarity, $F(1, 33) = 6.23$, $p = .018$, $\eta^2p = .159$, and likelihood, $F(1, 33) = 10.15$, $p = .003$, $\eta^2p = .235$.

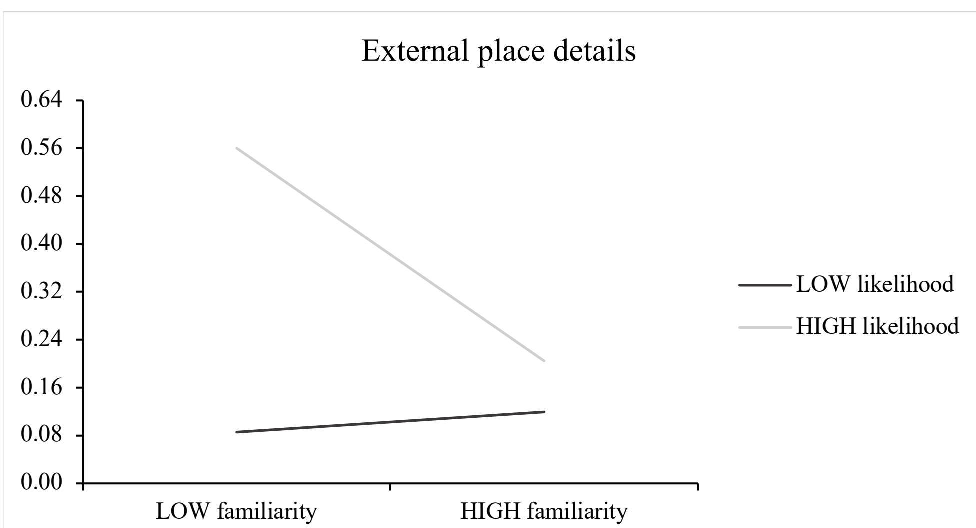

*Figure 6. Estimated marginal means of external place details (AI) across two levels of familiarity (HIGH-LOW) and two levels of likelihood (HIGH-LOW).*

The number of details that refers to localization in space, and are also external to the main event, seems to be affected by an interaction between familiarity and likelihood. Participants used significantly more external place related details when events have low levels of familiarity, but high levels of likelihood. These results should be interpreted cautiously because of the extremely low mean values.

4.4 Conclusions

The averaged perception of sounds, smells, and tastes seems to be positively and independently affected by high levels of familiarity, as well as by high levels of likelihood. There seems to be also a significant likelihood effect for high familiar events, but not for low familiar ones. Visual details perceived did not reflect any of these results, which may suggest that perception format (visual versus olfactive, auditory, and gustatory) is differently affected during the simulation by familiarity and likelihood.

The number of auditory, olfactory, tactile, gustatory, visual, and spatial-temporal details expressed by participants during the description of the simulation seems to be positively affected by an interaction between familiarity and likelihood. Participants used significantly more perceptual details when the events are highly familiar and highly likely. This outcome resembles results from the phenomenological sensory details perceived by participants, suggesting that sensory-perceptual information appears to be similarly influenced across methodological approaches.

The likelihood of an event positively and independently affects clarity of the physical arrangement of people and objects, as well as time of the day. Clarity in the time of the day was also similarly affected by familiarity with the events. Although in the same direction, both effects showed relative independence. The lack of an interaction on the clarity of physical arrangement, and time of the day, suggested that familiarity and likelihood effects on these variables are relatively independent between them.

# Chapter 5

## General discussion

We highlight two aspects of this research. First, the novelty of manipulating likelihood of events and testing for interactions between likelihood and familiarity. Secondly, taking a tailored approach that involved carefully constructed materials for each participant. As we predicted, likelihood plays a significant role in simulating future events.

### 5.1 The likelihood effect

The likelihood of an event happening in the future significantly enhanced the perceptual information perceived and produced when simulating future events. Importantly, this effect was significant only for highly familiar events but not for less familiar ones. EFT relies on two main components: one that makes use of event memories to construct a detailed event representation, and another one that integrates this event into a conceptual autobiographical context (Conway, 2001; D'Argembeau, 2015). Lehner and D'Argembeau, (2016) suggested that the crux of EFT lies in the conjunction of scene construction and contextualizing autobiographical knowledge. Our results support the relevance of both components for simulating future events and suggest how these two components may interrelate during EFT. Simulation of sensory-perceptual information in future events relies heavily on past memories so that high levels of knowledge enhance a person's ability to place the simulation in an autobiographical context. Sensory information was particularly affected, although it was only for non-visual perceptual information in the phenomenological measures. We found this combined effect on both phenomenological ratings and details in verbal descriptions of the simulation, showing the stability of the result across methodological approaches.

We found that likelihood also had independent effects in clarity of the context and time of the day. The subjective feeling of travelling through time to pre-experience autobiographical future events depends on the extent to which the events can be meaningfully placed in an autobiographical context. Highly likely events will be better contextualized autobiographically because they are expected to happen in people’s personal future. This independent effect of likelihood supports Lehner and D’Argembeau's (2016) results, who found that events "felt more real" because they were more aligned with what people expected in the future. In addition, Baumeister et al., (2016), in their pragmatic prospection theory, proposed that people think about the future to guide actions to bring about desirable outcomes. EFT related to people’s current goals have “privileged status” across cognitive and representational dimensions. Specifically, goal-related voluntary and involuntary simulations of future events were rated higher on sensory-perceptual vividness than unrelated ones (Cole & Berntsen, 2016). Similarly, we proposed that high likelihood reflects multiple pre-experienced simulations about future events. Personal goals presumably guided these repeated simulations. PSM model showed evidence that the likelihood of an event causes recurrent simulations about it (rumination). Repeatedly simulating a specific future presumably facilitates a person's ability to pre-experience it with increased clarity, which would be reflected in a more vivid phenomenological simulation.

5.2 The familiarity effect

High levels of familiarity were expected to enhance the phenomenological experience of mentally simulated future events. Constructing vivid scenarios of future events involves using knowledge previously acquired from multiple sources. Familiar events are those with a greater amount of associated information and knowledge, which positively impacts the phenomenological experience during simulation. The independent familiarity effects reflect the relevance of episodic memory for EFT. Overall, the vividness of a person's sensory experience should increase with event familiarity because thinking about the future involves using previous knowledge that enhances mental representations of future events (Szpunar & McDermott, 2008).

We found that not all the phenomenological variables were equally affected by familiarity. Sensorial experience associated with visual imagery showed a suspected ceiling effect in participant's responses. However, auditory, olfactive and tactile sensorial imagery was significantly affected by familiarity. Although we did not analyze sources of familiarity, we did find that familiarity and personal experience are closely related, which leads us to believe that personal experience is an important source of knowledge. The close association between familiarity and personal experience and the fact that personal experience is the preferred source of information when simulating future events (Anderson, 2012) could explain that more sensory information is available for simulation when events are highly familiar. It is possible that knowledge gained from other types of experience with events, such as watching videos and listening to stories, allowed people to rely on non-personal experiences to mentally simulate visual information. This may not be the case for auditory, olfactive and tactile information.

The mental representation of the time of day was significantly affected by familiarity. This seems at odds with the findings of Friedman, (1993) and D'Argembeau and Van der Linden, (2006), who found that when simulating future events, people rely less on past memories for the representation of the time of day and more on visual information recalled from the future event simulation, like, for example, lighting.

Interestingly, in contrast to clarity of the time of the day, familiarity did not influence the clarity of spatial context during the simulation. One potential explanation is that time of the day knowledge is less flexible than spatial context knowledge because the first could be more linked to previous personal experience. In other words, people recombine contents of memory to pre-experience events, but those contents may not be equally flexible for recombination. Consider, for example, the event "Attend my own wedding." The information about the place where the event is occurring, as well as the arrangement of people and objects, could arise from knowledge of and experience with similar events. For example, knowledge may come from being at other people's weddings, or events where people congregate to celebrate something. People acquire stereotypical knowledge from those events and because of it, they can imagine chairs and tables, family members, and a party space. In contrast, the representation of the time of the day could be more uncertain without high levels of familiarity. However, we do not rule out that some events have a stereotypical time of day, such as "Go trick or treating," which usually occurs during the evening. One implication of this variability in specific components or aspects of events is that it is advantageous to use more than one event per condition during EFT tasks.

5.3 The null results

For both likelihood and familiarity, perception of visual details was not significantly affected. Apparently, visual information is easily accessed regardless of whether the event is familiar or likely. Visual imagery plays an important role in autobiographical memory (Greenberg & Knowlton, 2014). Particularly during recall, visual imagery increases when there is a stronger sense of reliving (Rubin, 2006), and it facilitates autobiographical recall through the hierarchical structure of autobiographical memory (Conway & Pleydell-Pearce, 2000). Visual imagery and EFT are similarly affected in studies with clinical populations (El Haj et al., 2019). However, in our research, the simulation of future events in a non-clinical population showed a common richness of visual images for all participants. Regardless of the category (low or high familiarity and likelihood), participants were instructed to think about the event happening in their future. To guarantee a conscious autonoetic future simulation, we intentionally avoided extremely unlikely events. As a result, participants were able to simulate events with a strong feeling of visual pre-experiencing, and they were able to generate a similar number of visual details during the verbal description of the simulation.

Likelihood and familiarity did not influence the AI measures other than the production of perceptual details. Anderson (2012) found a similar result. The author concluded that EFT is flexible enough to enable one to envisage future events, both plausible and implausible, irrespective of whether the individual has personally experienced similar events previously. Interestingly, this author also suggested that this result does not rule out significant differences in the phenomenological experience of future events. According to our studies, the phenomenological experience was significantly affected by likelihood and familiarity during simulation, regardless of people's similarly detailed descriptions.

## 5.4 Future research

There are remaining questions that arise from our results, as well as aspects to refine in our current experimental design. First, it could be interesting to know more about the sources underlying familiarity and how they may affect sensory information during the simulation. Specifically, we could ask how the direct personal experience may lead to a more vivid simulation than nonpersonal sources when people simulate events with different future likelihoods.

It could also be interesting to consider event characteristics in the selection of events. For example, there may be differences among events that occur in a more social scenario (wedding) versus those that are more private (apply for university), or events that depend on specific previous events (getting married usually requires a marriage proposal) versus those that do not necessarily demand previous events (going on vacation).

Finally, in our design, events that were highly familiar but unlikely generally referred to events from previous developmental stages, specifically, childhood, so people do not expect them to occur in their future because of social-developmental reasons. However, in events that were unfamiliar and unlikely, the low expectation of them happening in the future may have a different origin. For example, it could be more due to personal goals. It is unclear if these differences may impact how participants understand likelihood, and they could be an aspect to refine in future designs.

### 5.5 Conclusions

Autonoetic consciousness, self, and personal goals are EFT-related components that can be better studied if researchers measure and take into account individual participants' perspectives. Approaching EFT by using tailored materials increases our confidence in the results. Additionally, by focusing on participants' experiences rather than selecting the same materials for all individuals, studies may be increasingly replicable across cultural contexts, in times during which scientific diversity has taken on increased importance.

We portrayed future event thinking as a dynamic process that involves more than recombining elements from the past. Taking into account the two main EFT components: one that refers to what we know, and another that refers to dynamically placing this knowledge in an autobiographically coherent future context (Conway, 2001; D'Argembeau, 2015; Lehner & D'Argembeau, 2016); the current results demonstrate that these two components (likelihood and familiarity) interact in a manner that facilitates people's ability to think about future events in a goal-coherent autobiographical framework.

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# Appendices

## Appendix A: Event generation survey (study 1)

**If you agree** to participate in the study, please indicate your consent below by clicking on the YES answer option.
You will then receive specific instructions for the study.
You do not waive any legal right by agreeing to participate.

- ○ YES
- ○ NO

Would you like to be contacted for future studies?

- ○ I would like to be contacted for future studies
- ○ I would not like to be contacted for future studies

If you have any questions, please contact Dr. Ken McRae at [redacted] and/or Claudia Morales-Valiente at [redacted]

Verification

☐ I'm not a robot — reCAPTCHA Privacy - Terms

The purpose of this study is to investigate the events that people expect to happen to them in the future and how familiar they are with those events. Please **carefully read the following**:

**What is an event?**
We can understand as an event "a segment of time at a given location that is conceived by an observer to have a beginning and an end" (Zacks & Tversky, 2001).
In addition to **locations** (a place, a restaurant, my home) and **segments of time**, events also involve **actions** (go, eat, sleep), **agents** (people, I, a friend) and **scripts** (order of steps, what you might do first, what you might do next, and so on).
People use short descriptions of events all the time to tell other people things that they have done, or that they will do. For example, you might tell someone that you "went to a concert with my friends" or that you "will take the bus to school tomorrow morning."

Events can be things that you do you quite often, like "making breakfast" or things that happen more rarely, like "going to a wedding".
In this study, we specifically are interested in events that might happen in your **future**.
There are two other event-related concepts that we'd like you to read and think about: Familiarity and Likelihood.

**What is meant by familiarity with an event?**
This concerns how much you know about an event, either because you have directly experienced something similar in the past (perhaps multiple times), or because you learned about it from other sources, such as through conversations, books, movies, videos, and so on.
For this study, we're going to divide Familiarity into two levels:

- *High familiarity*: I have quite a bit of knowledge about this type of event.
- *Low familiarity*: I have limited or no knowledge about this type of event.

**What is the likelihood of a future event?**
This concerns how certain you are that an event might happen to you in the future, taking into account your current situation.
For this study, you will consider "in the future" as in the next 10 years.
For the present study, we're going to divide Likelihood into two levels:

- *High likelihood*: I believe that it is highly likely this event is going to happen to me in the next 10 years.
- *Low likelihood:* I believe that it is highly unlikely that this event is going to happen to me in the next 10 years.

**Directions:**
We would like you to list events that fall into one of four categories shown below. On each category, you should list events that combine levels of Familiarity and Likelihood:
Categories:

- Familiar and likely events
- Unfamiliar and likely events
- Familiar and unlikely events
- Unfamiliar and unlikely events

**We ask you to please generate up to 15 events for each category.**
Please, select **NEXT** to see some examples of answers.

The following are examples of events that fit each category. These examples may not correspond to your answers because they are only intended to be general examples. A brief explanation is also included below each answer box.

Category:

**Familiar and likely events** (Event 1)

*Go to the doctor's office for a checkup*

This could be a familiar and likely event because you're probably quite familiar with going to the doctor's office for a checkup, and it's highly likely that you will do this again in the next 10 years.

Category:

**Familiar and unlikely events** (Event 1)

*Playing hide-and-seek in the playground*

You're probably quite familiar with "playing hide-and-seek in the playground" because you played it when you were a kid. However, it is highly unlikely that you will play hide-and-seek in a playground any time during the next 10 years.

Category:

**Unfamiliar and likely events (**Event 1)

*Doing my taxes*

This is an example of a potentially unfamiliar but likely event if it is the case that you have not filled out your taxes yourself yet, and you do not know a great deal about it, but you believe that it's highly likely that you will do your own taxes in the next 10 years.

Category:

**Unfamiliar and unlikely events (Event 1)**

*Be struck by lightning*

This would be an unfamiliar, unlikely event if you have no previous experience with being struck by lightning and you don't know a great deal about it, and in addition you believe that it is highly unlikely to happen to you in the next 10 years.

Please, click **NEXT** if you're ready or **PREVIOUS** if you need to see the instructions again

The survey will take approximately **1 hour**. Before you begin, please be sure that you have enough time to complete it

Please list 15 events that you are familiar with, and that are likely to happen during the next 10 years. Each event must be something in which you will be involved personally.

**Familiar and Likely (Event 1 of 15)**

(…)

You're doing great so far! Thank you!

Please list 15 events that you are not familiar with, and that are likely to happen during the next 10 years. Each event must be something in which you will be involved personally.

**Unfamiliar and Likely (Event 1 of 15)**

(…)

You have already completed half of the survey. Well done!

Please list 15 events that you are familiar with, and that are unlikely to happen to you during the next 10 years.

**Familiar and unlikely (Event 1 of 15)**

(…)

You are almost done with the survey!

Please list 15 events that you are not familiar with, and that are unlikely to happen to you during the next 10 years.

**Unfamiliar and unlikely (Event 1 of 15)**

(…)

This is your Random ID ${e://Field/Random%20ID}

Copy this value to paste in MTurk

When you have copied this ID, please click the next button to submit your survey

Powered by Qualtrics

## Appendix B: Letter of information

**Welcome! Thank you for participating in our study. Please, read the information below before you start the survey**

**Project Title**: Simulation of future events

**Principal Investigator:**
Ken McRae, Ph.D., Psychology
Brain and Mind Institute, [redacted]
Email: [redacted]
Telephone: [redacted]

**Study Contact:**
Claudia Morales-Valiente
Brain and Mind Institute, [redacted]
Email: [redacted]

**Invitation to Participate:** You are being invited to participate in this research study to help with gaining a greater understanding of how people simulate future events. You are being asked to participate because we are interested in adults' simulation of future events.

**Purpose of the Letter:** The purpose of this letter is to provide you with the information required for you to make an informed decision regarding participation in this research.

Study Procedures: You will be asked to do one or more of the following:

- Responding to a brief questionnaire about demographics.
- Responding to an online questionnaire relating to the simulation of events and memory.
- Completing a computer-based task where we will record responses to questions

**Possible Risks and Harms:** There are no known or anticipated risks or discomforts associated with participating in this study.

**Possible Benefits:** You may not directly benefit from participating in this study, but the knowledge gained may provide benefits to society as a whole. This study aims to obtain knowledge regarding how people simulate future events. The resulting knowledge about people's prospective memory for events is of potential benefit to society. Event knowledge is important to many aspects of cognition, including understanding the world around us, anticipating what might happen next, planning, and understanding language.

**Compensation**:

You will be compensated for your time.

**Voluntary Participation**: Your participation is voluntary. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time, for any reason, without loss of research credit. If you decide to withdraw from the study, you have the right to request (e.g., by phone, in writing, etc.) withdrawal of information collected about you. If you wish to have your information removed, please let the researcher know and your information will be destroyed from our records. Once the study has been published, we will not be able to withdraw your information.

**Confidentiality:** All data will be labeled with codes and will in no way be linked with your name or any other identification that could be associated with you, guaranteeing that your participation remains anonymous and confidential. If the results are published, your name will not be used. In published reports, data will typically be reported in aggregate (i.e., by averaging across multiple participants). However, some data may be published at the individual participant level (e.g., to provide examples or demonstrated individual differences). In all cases, data will be de-identified prior to publication. Your survey responses will be collected anonymously through a secure online survey platform called Qualtrics. Qualtrics uses encryption technology and restricted access authorizations to protect all data collected. In addition, Western's Qualtrics server is in Ireland, where privacy standards are maintained under the European Union safe harbor framework. The data will then be exported from Qualtrics and securely stored on Western University's server. Study records will be kept for 7 years, and then will be securely deleted electronically. Representatives of The University of Western Ontario Non-Medical Research Ethics Board may require access to your study-related records to monitor the conduct of the research.

**Contacts for Further Information:** Once your participation is complete, you will be debriefed, and you may ask any questions of the researcher. If you have any concerns regarding your participation or are interested in learning more about this research study, feel free to contact the principal investigators of this study, Claudia Morales-Valiente ([redacted]) and Dr. Ken McRae ([redacted]). If you have any questions about the conduct of the study or your rights as a research participant, please contact the Office of Human Research Ethics at the University of Western Ontario, [redacted], or [redacted]. This office oversees the ethical conduct of research studies and is not part of the study team. Everything that you discuss will be kept confidential.

**Publication:** The results of this study may be published as a Master's thesis, conference presentations, and/or a published article.

# Appendix C: Debriefing form

**Project Title:** Simulation of future events

**Principal Investigator:** Ken McRae,
McRae Cognitive Science Lab,
The Brain and Mind Institute, Western
University [redacted]

Thank you for your participation in this study. The purpose of this study was to examine the simulation of future events. We predicted that variables such as personal experience, familiarity, and likelihood, among others, will have an effect on the information that people produce while simulating future events. Here are some references if you would like to read more:

- Schacter, D. L., Benoit, R. G., & Szpunar, K. K. (2017). Episodic future thinking: Mechanisms and functions. *Current opinion in behavioral sciences*, 17, 41-50.
- Madore, K. P., Gaesser, B., & Schacter, D. L. (2014). Constructive episodic simulation: Dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40(3), 609.
- Addis, D. R., Musicaro, R., Pan, L., & Schacter, D. L. (2010). Episodic simulation of past and future events in older adults: Evidence from an experimental recombination task. *Psychology and aging*, 25(2), 369.

We would like to remind you that your results are confidential to the experimenters and that all results are published anonymously as a group data. If you have any questions or concerns, please contact Claudia Morales-Valiente [redacted] or Ken McRae [redacted]

Thank you,
Claudia Morales-Valiente
McRae Cognitive Science Lab,
The Brain and Mind Institute, Western University
[redacted]

## Appendix D: Ethics approval letter

**Date:** 28 July 2020

**To:** Prof. Kenneth McRae

**Project ID:** 115937

**Study Title:** Simulation of future events

**Short Title:** Simulation of future events

**Application Type:** NMREB Initial Application

**Review Type:** Delegated

**Full Board Reporting Date:**

August 7 2020 **Date Approval**

**Issued:** 28/Jul/2020

**REB Approval Expiry Date:**

28/Jul/2021

Dear Prof. Kenneth McRae

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the above mentioned study, as of the date noted above. NMREB approval for this study remains valid until the expiry date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

**Documents Approved:**

| Document Name | Document Type | Document Date | Document Version |
|---|---|---|---|
| [redacted] | Recruitment Materials | 14/May/2020 | 1 |
| [redacted] | Paper Survey | 02/Jun/2020 | 1 |
| [redacted] | Online Survey | 02/Jun/2020 | 1 |
| [redacted] | Online Survey | 02/Jun/2020 | 1 |
| [redacted] | Online Survey | 02/Jun/2020 | 1 |

| | | | |
|---|---|---|---|
| [redacted] | Debriefing document | 02/Jun/2020 | 1 |
| [redacted] | Written Consent/Assent | 02/Jun/2020 | 1 |
| [redacted] | Implied Consent/Assent | 02/Jun/2020 | 1 |
| [redacted] | Recruitment Materials | 21/Jul/2020 | 2 |
| [redacted] | Recruitment Materials | 21/Jul/2020 | 2 |
| [redacted] | Recruitment Materials | 21/Jul/2020 | 2 |
| [redacted] | Recruitment Materials | 21/Jul/2020 | 2 |
| [redacted] | Recruitment Materials | 21/Jul/2020 | 2 |

No deviations from, or changes to the protocol should be initiated without prior written approval from the NMREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario

Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Kelly Patterson, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

***Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).***

## Appendix E: List of events for Study

List 1

Act in a movie scene
Adopt a child
Assemble furniture
Babysit a newborn for an evening
Bob for apples
Buy a CD
Celebrate one of my parent's birthday
Cheer for a sports team that's not my favorite one
Clean my room
Colour a picture
Declare bankruptcy
Declare my belongings at customs
Do my Spring cleaning
Eat at a fast-food restaurant
Get arrested
Get carried upstairs to bed after falling asleep in the car
Get laser eye surgery
Get mauled by a bear
Give out Halloween candy
Give someone CPR
Go boating on a lake
Go hunting
Go scuba diving
Go sledding
Go to a Disney theme park for a day
Go to a high school science class
Go to a museum
Go to family reunion
Go to the beach
Go to the gym
Go to the zoo
Go white-water rafting
Lock my keys in my car
Lose my phone
Meet with a lawyer
Move into my first home
Paint a room
Participate on a game show
Play tag
Represent a client in court
Run a marathon in the desert
Steal something from a store
Take a domestic flight
Test drive a new car
Visit a volcano

List 2

Apply for an undergraduate program
Ask for promotion at work
Attend a group interview for a new job
Attend my own wedding
Break a neighbour's window
Bring children to sports practice
Buy crayons
Change the oil in my car
Come up with a lucrative business idea
Cook dinner from scratch
Dress up for Halloween
Drive a bus
Enroll a child in school
Get a piercing
Get a speeding ticket
Get in a car accident
Get laser hair removal
Get scammed for $10,000
Give a presentation at work
Go camping
Go get an ice-cream cone
Go on a first date with someone
Go shopping for professional clothing
Go surfing
Go to a bar with friends
Go to a Chuck E. Cheese
Go to a professional football game
Go to a yoga class
Go to the doctor
Go to the movies
Have a campfire with friends
Have a nerf gun fight with friends
Interview for jury duty
Join the military
Meet a celebrity
Open gifts on a holiday
Participate in a charity run
Play in a playground
Play with toys
Put up holiday decorations
Record a chart-topping song
Sing with a celebrity
Swim in a kiddie pool
Swim with sharks
Take a professional exam
Visit a tourist attraction
Write a final exam
Run a yard sale

List 3

Announce my candidacy for political office
Apply for a business loan
Attend an open house for a house for sale
Be the maid of honour or best man at a friend's wedding
Break a bone
Buy a new cellphone
Buy a new home
Change a flat tire on my car
Climb a mountain
Cook a holiday meal by myself
Direct a movie scene
Do my taxes
First day at a new job
Fly a helicopter
Gamble in Las Vegas
Get bitten by a poisonous snake
Get contact lenses
Get fired from a job
Get mugged
Give a presentation at a town council meeting
Give someone an expensive graduation gift
Go to a neighborhood holiday party
Go bungee jumping
Go out to dinner with a romantic partner
Go snorkeling
Go swimming at a pool
Go to a piano lesson
Go to a work meeting
Go to the emergency room
Go to the library
Go to watch fireworks
Hang out with friends from elementary school
Install new floors in my house
Join a cult
Lose my wedding ring
Make a large breakfast on the weekend
Meet with customers at work
Play board games with friends
Play hide-and-seek
Punch someone
Rescue a wounded animal
Sing in public
Sit on Santa's lap in a mall
Survive a tornado
Visit a newborn in my family
Vote in an election
Watch penguins in the wild
Escape a burning building

List 4

Ask my partner to move in with me
Attend an Olympic event
Babysit the neighbour's children
Build a snowman
Buy a new bed
Celebrate my wedding anniversary
Collect rocks and paint them
Complete a home renovation project
Dance in a flash mob
Design a website
Eat at a fancy restaurant
Eat bugs
File for divorce
Get a mortgage
Get a new pet
Get a tattoo
Get braces on my teeth
Get lost in the jungle
Get struck by lightning
Give a speech in public
Give birth to a child
Go fishing
Go on a hike
Go sailing for a day
Go shopping for clothes
Go to a concert
Go to a friend's birthday party
Go to a high school graduation
Go to an optometrist
Go to the salon to get my hair cut
Go trick-or-treating
Hit a pinata at a birthday party
Host a barbecue
Join a play group for my child
Jump out of a plane
Meet the Prime Minister
Order clothes online
Participate in a protest
Propose to someone
Reorganize my apartment
Repair a computer by myself
Ride a horse
Start my own business
Take my pet to the veterinarian
Travel in a spaceship
Wake up early to watch cartoons

## Appendix F: Events evaluation survey (studies 2 and 3)

Western
UNIVERSITY · CANADA

**If you agree** to participate in the study, please indicate your consent below by clicking on the YES answer option. You will then receive specific instructions for the study.
You do not waive any legal right by agreeing to participate.

- ○ YES
- ○ NO

Would you like to be contacted for future studies?

- ○ I would like to be contacted for future studies
- ○ I would not like to be contacted for future studies

If you have any questions, please contact Dr. Ken McRae at [redacted] and/or Claudia Morales-Valiente at [redacted]

Verification

☐ I'm not a robot — reCAPTCHA Privacy - Terms

Please, complete the following demographic information about yourself. You can skip any questions if you prefer not to answer.

Age (in years) [ ]

Gender with which you identify yourself

- ○ Female
- ○ Male
- ○ Other

- ○ Prefer not to answer

Is English your first language?

- ○ Yes
- ○ No

What is the highest level of education you have completed?

- ○ Elementary School
- ○ High School
- ○ 1st year of College/University
- ○ 2nd year of College/University
- ○ 3rd year of College/University
- ○ Graduated from College/University
- ○ Some Graduate School
- ○ Completed Graduate School
- ○ I prefer not to answer

**Instructions**

The purpose of this study is to investigate how people evaluate events that may or may not happen in their future. Please carefully read the following:

**What is an event?**

We can understand as an event "a segment of time at a given location that is conceived by an observer to have a beginning and an end" (Zacks & Tversky, 2001).

In addition to locations (a place, a restaurant, my home) and segments of time, events also involve actions (go, eat, sleep), agents (people, I, a friend) and scripts (order of steps, what you might do first, what you might do next, and so on).

People use short descriptions of events all the time to tell other people things that they have done, or that they will do. For example, you might tell someone that you "went to a concert with my friends" or that you "will take the bus to school tomorrow morning."

Events can be things that you do you quite often, like "making breakfast" or things that happen more rarely, like "going to a wedding".

In this study, we specifically are interested in events that might happen in your future.

There are two other event-related concepts that we'd like you to read and think about: Familiarity and Likelihood.

**What is meant by familiarity with an event?**

This concerns how much you know about an event, either because you have directly experienced something similar in the past (perhaps multiple times), or because you learned about it from other sources, such as through conversations, books, movies, videos, and so on.

**What is the likelihood of a future event?**

This concerns how certain you are that an event might happen to you in the future, taking into account your current situation.

For this study, you will consider "in the future" as during the next 10 years.

**Directions:**

We would like you to rate the events according to what is asked on each trial.

The survey will take about 1 hour. So, please, be sure that you have enough time to complete it

Event 1

*Act in a movie scene*

How familiar are you with this event?

| Very unfamiliar | | | Somewhat familiar | | Very familiar | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

How likely is it that this event will happen to you during the next 10 years?

| Very unlikely | | | Somewhat likely | | Very likely | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

How often during the next 10 years do you think this event might happen?

| Never | Once | A few times | Often |
|---|---|---|---|

If this event happened to you in the future, your emotions would be:

| Very negative | | | Neutral | | | Very positive |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

How often have you thought about this event happening in your future?

| Never | | | Sometimes | | | Very often |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Have you been personally involved in this specific event in the past?

| Never | | | A few times | | | Many times |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

# Appendix G: Descriptive data of the final set of events for study 3

*Table. Control variables mean scores in the final selection of events*

| Event | Familiarity | Likelihood | Difference | Emotional valence | Personal experience | Future frequency | Rumination |
|---|---|---|---|---|---|---|---|
| High Familiarity-High Likelihood | | | | | | | |
| Build a snowman | 6.33 | 6.00 | 0.33 | 3.05 | 6.29 | 3.29 | 6.10 |
| Have a campfire with friends | 6.24 | 6.38 | 0.14 | 3.57 | 6.38 | 4.71 | 5.90 |
| Cook dinner from scratch | 5.81 | 6.71 | 0.90 | 3.81 | 5.43 | 5.38 | 6.00 |
| Visit a tourist attraction | 6.29 | 6.43 | 0.14 | 3.38 | 6.38 | 5.62 | 6.14 |
| Give a speech in public | 5.05 | 5.24 | 0.19 | 3.00 | 3.86 | 3.90 | 5.14 |
| Go to the zoo | 5.30 | 5.25 | 0.05 | 2.75 | 5.45 | 3.20 | 5.26 |
| Go to a concert | 5.10 | 5.95 | 0.86 | 2.95 | 6.48 | 5.10 | 4.29 |
| Go boating on a lake | 4.85 | 5.25 | 0.40 | 2.95 | 5.95 | 4.32 | 4.50 |
| Go to the beach | 6.10 | 6.40 | 0.30 | 3.50 | 6.40 | 5.60 | 6.35 |
| Eat at a fancy restaurant | 5.81 | 6.52 | 0.71 | 3.29 | 6.43 | 4.10 | 5.43 |
| Low Familiarity-Low Likelihood | | | | | | | |
| Watch penguins in the wild | 2.16 | 2.53 | -0.37 | 1.63 | 6.11 | 2.32 | 1.37 |
| Participate on a game show | 2.65 | 1.60 | 1.05 | 1.30 | 5.20 | 2.70 | 1.10 |
| Dance in a flash mob | 2.67 | 2.48 | 0.19 | 1.57 | 5.10 | 1.86 | 1.86 |
| Record a chart-topping song | 2.71 | 1.43 | 1.29 | 1.24 | 5.86 | 1.86 | 1.33 |
| Fly a helicopter | 1.79 | 1.79 | 0.00 | 1.16 | 4.89 | 1.63 | 1.11 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Go sailing for a day | 2.48 | 3.52 | -1.05 | 2.24 | 5.57 | 2.81 | 2.24 |
| Represent a client in court | 1.75 | 1.95 | -0.20 | 1.60 | 4.75 | 2.80 | 1.00 |
| Rescue a wounded animal | 2.68 | 3.16 | -0.47 | 2.05 | 4.84 | 2.58 | 2.00 |
| Act in a movie scene | 2.35 | 1.90 | 0.45 | 1.45 | 5.30 | 3.15 | 1.20 |
| Sing with a celebrity | 2.10 | 1.43 | 0.67 | 1.10 | 4.90 | 1.57 | 1.05 |
| Direct a movie scene | 1.84 | 1.16 | 0.68 | 1.05 | 5.58 | 2.47 | 1.21 |
| High Familiarity-Low Likelihood | | | | | | | |
| Wake up early to watch cartoons | 4.62 | 2.52 | 2.10 | 2.10 | 4.95 | 1.71 | 4.95 |
| Swim in a kiddie pool | 5.14 | 2.86 | 2.29 | 1.95 | 4.00 | 1.57 | 4.67 |
| Go to a Chuck E. Cheese | 5.10 | 2.19 | 2.90 | 1.52 | 4.38 | 1.62 | 3.76 |
| Apply for an undergraduate program | 6.10 | 2.86 | 3.24 | 1.33 | 4.05 | 3.10 | 3.38 |
| Sit on Santa's lap in a mall | 5.32 | 1.32 | 4.00 | 1.11 | 3.47 | 1.11 | 5.16 |
| Get braces on my teeth | 5.14 | 1.05 | 4.10 | 1.05 | 1.95 | 1.24 | 3.90 |
| Go to a high school science class | 6.45 | 1.35 | 5.10 | 1.15 | 3.50 | 1.20 | 6.55 |
| Play tag | 5.90 | 3.20 | 2.70 | 2.50 | 5.35 | 2.53 | 6.45 |
| Go to a high school graduation | 4.43 | 2.48 | 1.95 | 1.48 | 5.19 | 3.38 | 2.00 |
| Go trick-or-treating | 6.62 | 2.86 | 3.76 | 1.95 | 5.62 | 2.29 | 6.05 |

| Low Familiarity-High Likelihood | | | | | | | |
|---|---|---|---|---|---|---|---|
| Do my taxes | 2.37 | 6.95 | -4.58 | 3.68 | 3.11 | 4.00 | 1.95 |
| Move into my first home | 2.70 | 6.20 | -3.50 | 2.35 | 6.45 | 4.80 | 1.75 |
| Ask my partner to move in with me | 2.29 | 5.57 | -3.29 | 2.14 | 6.52 | 4.43 | 1.14 |
| Change the oil in my car | 3.14 | 5.76 | -2.62 | 3.19 | 3.67 | 2.43 | 1.71 |
| Meet with a lawyer | 1.80 | 4.10 | -2.30 | 2.55 | 3.75 | 3.15 | 1.40 |
| Get a mortgage | 2.52 | 4.81 | -2.29 | 2.10 | 3.29 | 1.33 | 3.90 |
| Attend my own wedding | 2.81 | 5.00 | -2.19 | 1.90 | 6.81 | 5.38 | 1.14 |
| Be the maid of honour or best man at a friend's wedding | 2.58 | 4.63 | -2.05 | 2.00 | 6.53 | 4.47 | 1.00 |
| Test drive a new car | 3.40 | 5.45 | -2.05 | 2.75 | 5.75 | 4.25 | 2.15 |
| Change a flat tire on my car | 2.68 | 4.63 | -1.95 | 2.63 | 2.63 | 2.32 | 1.74 |
| Buy a new home | 3.16 | 5.68 | -2.53 | 2.11 | 5.89 | 5.21 | 2.37 |

# Appendix H: Propensity scores matching (PSM) results

```
. psmatch2 LIK_TREAT FAMILIARITY FUTURE_FREQ EMOTION, out( RUMINATION)

Probit regression                               Number of obs     =        187
                                                LR chi2(3)        =     181.50
                                                Prob > chi2       =     0.0000
Log likelihood = -38.864516                     Pseudo R2         =     0.7002

------------------------------------------------------------------------------
   LIK_TREAT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 FAMILIARITY |  -.2569931   .1675767    -1.53   0.125    -.5854373    .0714512
 FUTURE_FREQ |   3.447237   .5996992     5.75   0.000     2.271848    4.622626
     EMOTION |   .2924211   .1406773     2.08   0.038     .0166986    .5681436
       _cons |  -8.388218   1.443293    -5.81   0.000    -11.21702   -5.559417
------------------------------------------------------------------------------

----------------------------------------------------------------------------------------
        Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
----------------------------+-----------------------------------------------------------
      RUMINATION  Unmatched | 4.02465472   2.32109171   1.70356301   .124345749    13.70
                        ATT | 4.02465472   2.66999947   1.35465526   .563641686     2.40
----------------------------+-----------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.

           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |        93 |        93
   Treated |        94 |        94
-----------+-----------+----------
     Total |       187 |       187
```

*Figure. PSM model 1 with rumination as independent variable; familiarity, future frequency, and emotion as control variables; and likelihood as dependent variable.*

```
. psmatch2 RUM_TREAT FAMILIARITY FUTURE_FREQ EMOTION, out ( LIKELIHOOD )

Probit regression                                 Number of obs     =        187
                                                  LR chi2(3)        =     118.85
                                                  Prob > chi2       =     0.0000
Log likelihood = -70.190469                       Pseudo R2         =     0.4585

------------------------------------------------------------------------------
   RUM_TREAT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 FAMILIARITY |  -.1169421   .1167937    -1.00   0.317    -.3458536    .1119694
 FUTURE_FREQ |   1.364668   .2501241     5.46   0.000     .8744336    1.854902
     EMOTION |   .4531658   .1063413     4.26   0.000     .2447406     .661591
       _cons |  -4.895326   .6721605    -7.28   0.000    -6.212737   -3.577916
------------------------------------------------------------------------------

----------------------------------------------------------------------------------------
        Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
----------------------------+-----------------------------------------------------------
      LIKELIHOOD  Unmatched | 5.45628453   2.69481016   2.76147436   .180684123    15.28
                        ATT | 5.45628453   5.09566389   .360620638   .592021749     0.61
----------------------------+-----------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.

           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |        94 |        94
   Treated |        93 |        93
-----------+-----------+----------
     Total |       187 |       187
```

*Figure. PSM model 2 with rumination as independent variable; familiarity, future frequency, and emotion as control variables; and likelihood as dependent variable.*

```
. psmatch2 FAM_TREAT RUMINATION FUTURE_FREQ EMOTION, out ( LIKELIHOOD )

Probit regression                                 Number of obs     =        187
                                                  LR chi2(3)        =      93.57
                                                  Prob > chi2       =     0.0000
Log likelihood = -82.831168                       Pseudo R2         =     0.3609

------------------------------------------------------------------------------
   FAM_TREAT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  RUMINATION |  -.1811218   .1381169    -1.31   0.190    -.4518259    .0895823
 FUTURE_FREQ |   1.319249    .204082     6.46   0.000     .9192555    1.719242
     EMOTION |   .1531822   .0929231     1.65   0.099    -.0289437    .3353081
       _cons |  -3.178438   .4660171    -6.82   0.000    -4.091815   -2.265062
------------------------------------------------------------------------------

----------------------------------------------------------------------------------------
        Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
----------------------------+-----------------------------------------------------------
      LIKELIHOOD  Unmatched | 5.16191409    2.9626526   2.19926149   .218454507    10.07
                        ATT | 5.16191409   5.37971924  -.217805151   .672374229    -0.32
----------------------------+-----------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.

           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |        93 |        93
   Treated |        94 |        94
-----------+-----------+----------
     Total |       187 |       187
```

*Figure. PSM model 3 with familiarity as independent variable; rumination, future frequency, and emotion as control variables; and likelihood as dependent variable.*

# Appendix I: Levine Lab materials for Autobiographical interview administration and scoring

**Brian Levine, PhD, ABPP**

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Rotman Research Institute
[redacted]

Professor
Departments of Psychology and Medicine (Neurology)
University of Toronto

[redacted]
Fax: [redacted]
Email: [redacted]
Web: [redacted]

Rotman Research Institute

May 1, 2020

Dear Dr Ken McRae,

Enclosed are the following materials for administration and scoring of our Autobiographical Interview.

1) CD containing:
   a) Test administration instructions
   b) Scoring manual
   c) Unscored versions of the five practice memories, 20 reliability memories, and spreadsheets for scoring and assessing reliability.
   d) Our first paper on this task, which should be the primary citation for the administration and scoring methods.
   e) Two sample transcribed, scored, and annotated memories, with attached scoresheets
2) Five scored "practice" memories
3) 20 scored memories for the formal reliability study (please note that we have included only one established scorer's scored memories to be used as an example)

As specified in the instructions, there are two main levels of recall for each event: free recall / general probe and specific probe. In the free recall / general probe phase, examiner input is limited to non-specific instructions and guidance. More aggressive cueing by the examiner is permitted in the specific probe phase. It is important that free recall / general probe is completed for all events before specific probe is initiated to prevent contamination of subsequent events by the examiner's probing. After the interview is transcribed, the sequence of material is re-arranged for scoring purposes such that specific probe follows general probe for each memory. At this stage the memories may also be "censored" to remove information about group membership if the scorer is to be blinded. Learning test administration may be facilitated by examining the transcribed memories included with this package (keeping in mind that the sequence of probing was re-arranged).

Note that the administration method is changed slightly from that described in the Psychology and Aging article, where we presented the event list at the beginning of the test. Also, in the aging study, we did not separate free recall and general probe in the analyses because the data did not suggest general probing provided significant additional retrieval support. In a later study (St.-Jacques and Levine, 2007), we did find such an effect. We therefore recommend examining free recall and general probe separately before combining them. In the attached instructions, 5 events across the life span, but any number of events can be collected depending on questions being addressed. Although we use the time period as a cue for event generation (supplemented by the event list) any retrieval cue may be used, depending on the goals of the study.

We strongly recommend that all of the following procedures are used to establish reliability in scoring. Failure to follow these procedures may result in reduced sensitivity or erroneous findings.

1) Get acquainted with the scoring manual and examine the annotated memories.
2) Print the five practice memories from the CD. Score them in an "open-book" fashion using the scored versions provided on hard copy.
3) Once you are comfortable with the method, print the first set (memories 1-1 to 1-5) of the reliability memories and score them without referring to the scored versions.
4) Tally up scores for internal and external detail categories and ratings. Enter your scores on the blank scoresheet (provided on CD). Total internal, external and ratings composites will be automatically generated in the last column if you enter the scores electronically. Otherwise, sum the scores manually (taking care not to include the AMI rating in the ratings composite)
5) Transfer the internal, external, and ratings composites to the "Scorer in training" columns on the correlation spreadsheet (included on the CD). Be sure to sum details cumulatively across free recall, general probe, and specific probe (this is not done automatically on the scoresheet or in the correlation spreadsheet). That is, the sum of the free recall and general probe detail composites is entered in the "FR + GP" column, and the sum of free recall, general probe, and specific probe detail composites is entered in the "FR + GP + SP" column. Ratings are not summed as the ratings for the prior retrieval support conditions are taken into consideration when assigning ratings during general probe and specific probe (see scoring manual). Comments inserted in the spreadsheet for guidance may be turned on or off from the "View" menu.
6) Correlations will be automatically generated in the "Scorers Correlations" section of the spreadsheet. You may compare your scores to the established scorers individually and collectively. Examination of the established scorers' correlations amongst themselves will give you an idea of the normal range of variability in correlations. Correlations should be examined separately for FR + GP and FR + GP + SP. Correlations for total details indicate how the protocol is being segmented (i.e., are there too many or too few details?). Assuming segmentation is accurate, correlations with internal and external details indicate how accurately the details are distributed across internal and external categories. These correlations can be affected by differences in event definition. That is, if two scorers define the event differently (i.e., which aspect of the protocol constitute the "main event"), details at the boundaries of the event will be categorized differently.

7) Where correlations are low, find the problem by examining composite scores for individual memories in comparison with established scorers as entered on the spreadsheet. Determine if the problem lies in over-segmentation or under-segmentation (i.e., elevated or reduced total details) or incorrect assignment of details across internal and external categories. Go to the scoresheets and scored transcriptions to attempt to localize the problem further.
8) Following examination of the composite scores, individual categories may be examined. Reliability for these categories will always be lower than for the composites. Rather than examine correlations, we have found it useful to look at the raw scores on the score sheets and look for patterns of differences (e.g., scoring place details as perceptual). Again, go to the scored protocol and look at the scoring for selected problematic memories. However, we discourage obsessing over the scored protocols. Reliability is never perfect.
9) Repeat the process for the each set of five memories until you have scored all 20. Examine correlations for the set individual, as well as correlations cumulatively across all sets. These are included in the spreadsheet, as well as correlations excluding set 1, in case there were problems in the initial scoring.

Some caveats:

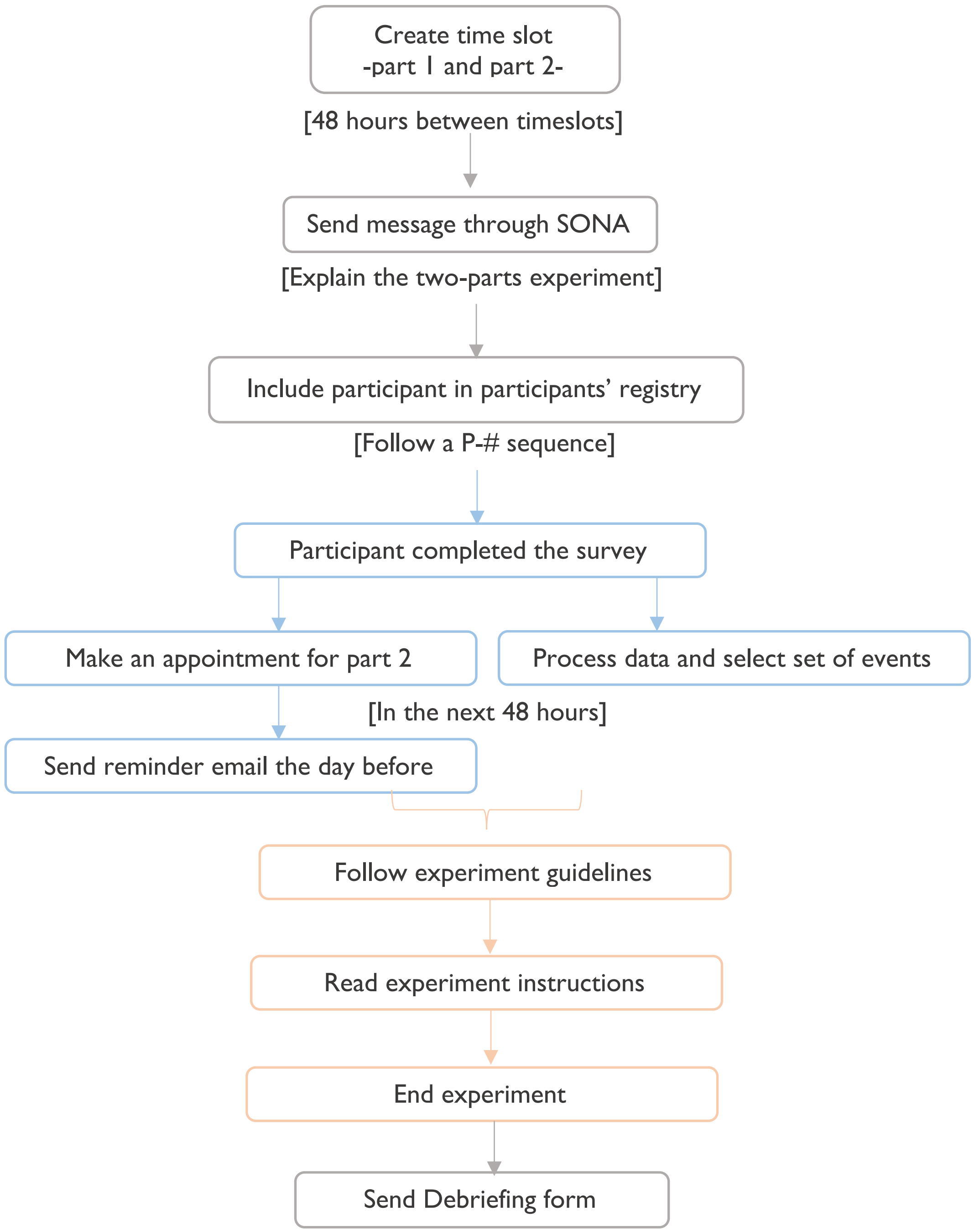
1) There are four established scorers. Their scores are not available for all reliability memories.
2) There have been some refinements to the scoring manual since these memories were scored, which may have a small effect on correlations.
3) In interpreting reliability scores across the full set of 20 memories, keep in mind that reliability may be reduced by the inclusion of earlier memories. On the other hand, the 4 sets of memories are not equivalent (in particular, set 2 is harder than set 1).
4) Correlations for composite scores should be in the range of 0.80-0.95 (except for ratings at specific probe, which have limited range due to ceiling effects, lowering correlations).
5) It is recommended that memories be scored by someone other than the person who administered the test, although it is recognized that this is not always practical. In any case, it is helpful for the test administrator to know the scoring system.
6) In the Psychology and Aging paper, the time integration rating was not included in the ratings composite, as it was not considered to strictly reflect episodic re-experiencing. It is, however, included in the ratings composite on the reliability spreadsheet.

I am releasing these materials with the understanding that they are to be used for research purposes only. Please do not distribute these materials to others. Instead, have them contact me. Finally, I would be very interested to learn of what you find with our test.

Sincerely,

[redacted]

## Appendix J: Study 3 protocol timeline



# Appendix K: Example of Autobiographical interview segmentation and categorization analysis

Event: *Test drive a new car*

## 1. Segmentation

*[So, for this one I imagine myself… I'm in the back] [of like a car dealership area or like just a place where they have cars] [that you can test] [and it's a new car] [it's it's kind of small] [and it's blue] [and there's a driving or a person with me] [who is like an expert on the car] [and I'm driving the car] [in like a wide-open] [area] [and there're like lanes and stuff] [so I can practice] [doing like different tricks] [or or just seeing the speed] [and and all of that] [and… and the weather outside makes it seem like it's a little cloudy] [and… the sun just came up] [so it's probably like in the morning.]*

## 2. Categorization

Legend:

| | |
|---|---|
| ED-INT | Episodic detail-internal |
| PR-INT | Perceptual detail-internal |
| PL-INT | Place detail-internal |
| TIME-INT | Time detail-internal |

PR-INT PL-INT

[So, for this one I imagine myself… I'm in the back] [of like a car dealership area or like just a

ED-INT ED-INT PR-INT PR-INT

place where they have cars] [that you can test] [and it's a new car] [it's it's kind of small] [and it's

ED-INT ED-INT

blue] [and there's a driving or a person with me] [who is like an expert on the car] [and I'm

ED-INT PR-INT PL-INT PR-INT ED-INT

driving the car] [in like a wide-open] [area] [and there're like lanes and stuff] [so I can practice]

ED-INT ED-INT PR-INT

[doing like different tricks] [or or just seeing the speed] [and and all of that] [and… and the

PR-INT

weather outside makes it seem like it's a little cloudy] [and… the sun just came up] [so it's

TIME-INT

probably like in the morning.]

## Appendix L: Autobiographical interview score sheet (provided by Levine Lab)

| | | | |
|---|---|---|---|
| **Rater:** | | | |
| **EVENT 1:** | | | |
| | Details | | Rating |
| | Internal | External | |
| Event detail | | | |
| Place | | | |
| Time | | | |
| Perceptual | | | |
| Emotion/Thoughts | | | |
| Semantic detail | | | |
| Repetitions | | | |
| Other | | | |
| AMI rating | | | |
| Time integration | | | |
| Episodic richness | | | |
| Totals | 0 | 0 | 0 |

# Appendix M: Tables of ANOVAs of phenomenological scores

*Table. Within-within subjects' 2x2 factorial ANOVA with Visual details as dependent variable*

| | Type III Sum of Squares | Mean Square | F | *p* | $\eta^2p$ |
|---|---|---|---|---|---|
| Familiarity | 2.01 | 2.01 | 3.38 | .075 | .093 |
| Likelihood | 0.09 | .090 | 0.23 | .639 | .007 |
| Familiarity ✻ Likelihood | 0.09 | .090 | 0.27 | .610 | .008 |

*Note: Familiarity ✻ Likelihood indicates the interaction.*

*Table. Within-within subjects' 2x2 factorial ANOVA with Sensory details as dependent variable*

| | Type III Sum of Squares | Mean Square | F | *p* | $\eta^2p$ |
|---|---|---|---|---|---|
| Familiarity | 5.72 | 5.72 | 9.66 | .004** | .226 |
| Likelihood | 2.01 | 2.01 | 4.43 | .043** | .118 |
| Familiarity ✻ Likelihood | 4.56 | 4.56 | 4.63 | .039** | .123 |

*Table. Within-within subjects' 2x2 factorial ANOVA with Time of day as dependent variable*

| | Type III Sum of Squares | Mean Square | F | *p* | $\eta^2p$ |
|---|---|---|---|---|---|
| Familiarity | 24.31 | 24.31 | 13.23 | .001* | .286 |
| Likelihood | 10.90 | 10.90 | 6.45 | .016* | .163 |
| Familiarity ✻ Likelihood | 0.02 | 0.02 | 0.01 | .915 | .000 |

*Note: Familiarity ✻ Likelihood indicates the interaction.*

*$p < .01$

# Appendix N: Tables of ANOVAs of autobiographical interviews

*Table. Autobiographical interview ANOVAs results (Mean squared, F, p, η²p)*

| Variables | *Internal* | | | | *External* | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean Square | F | *p* | η²p | Mean Square | F | *p* | η²p |
| Episodic details | | | | | | | | |
| Familiarity | 0.97 | 0.19 | 0.666 | 0.006 | 0.31 | 0.74 | 0.396 | 0.022 |
| Likelihood | 1.15 | 3.16 | 0.578 | 0.009 | 0.81 | 1.56 | 0.220 | 0.045 |
| Familiarity ✻ Likelihood | 2.80 | 0.65 | 0.426 | 0.019 | 0.22 | 0.50 | 0.485 | 0.015 |
| Place details | | | | | | | | |
| Familiarity | 0.81 | 1.48 | 0.233 | 0.043 | 0.60 | 6.23 | 0.018* | 0.159 |
| Likelihood | 1.34 | 2.44 | 0.128 | 0.069 | 1.06 | 10.15 | 0.003* | 0.235 |
| Familiarity ✻ Likelihood | 0.15 | 0.18 | 0.677 | 0.005 | 0.735 | 8.78 | 0.006** | 0.210 |
| Time details | | | | | | | | |
| Familiarity | 1.24 | 2.76 | 0.106 | 0.077 | 0.01 | 0.11 | 0.744 | 0.003 |
| Likelihood | 0.27 | 0.96 | 0.335 | 0.028 | 0.01 | 0.19 | 0.661 | 0.006 |
| Familiarity ✻ Likelihood | 0.03 | 0.90 | 0.769 | 0.003 | 0.01 | 0.19 | 0.661 | 0.006 |
| Perceptual details | | | | | | | | |
| Familiarity | 2.94 | 0.57 | 0.455 | 0.017 | 0.09 | 0.89 | 0.353 | 0.026 |
| Likelihood | 7.07 | 2.08 | 0.159 | 0.059 | 0.22 | 2.28 | 0.140 | 0.065 |
| Familiarity ✻ Likelihood | 37.07 | 11.17 | 0.002* | 0.002 | 0.46 | 0.42 | 0.523 | 0.012 |
| Emotion/thoughts details | | | | | | | | |
| Familiarity | 0.01 | 0.01 | 0.966 | 0.000 | 0.01 | 0.06 | 0.810 | 0.002 |
| Likelihood | 0.02 | 0.03 | 0.865 | 0.001 | 0.12 | 0.82 | 0.373 | 0.024 |
| Familiarity ✻ Likelihood | 1.34 | 0.91 | 0.346 | 0.027 | 0.03 | 0.22 | 0.640 | 0.007 |
| Semantic details | | | | | | | | |
| Familiarity | - | - | - | - | 0.07 | 0.21 | 0.648 | 0.006 |
| Likelihood | - | - | - | - | 0.18 | 0.38 | 0.545 | 0.011 |
| Familiarity ✻ Likelihood | - | - | - | - | 0.01 | 0.02 | 0.899 | 0.000 |
| Repetitions | | | | | | | | |
| Familiarity | - | - | - | - | 0.26 | 1.56 | 0.221 | 0.045 |
| Likelihood | - | - | - | - | 0.07 | 0.36 | 0.552 | 0.011 |
| Familiarity ✻ Likelihood | - | - | - | - | 0.03 | 0.18 | 0.673 | 0.005 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Others | | | | | | | | |
| Familiarity | - | - | - | - | 0.15 | 1.44 | 0.239 | 0.042 |
| Likelihood | - | - | - | - | 0.09 | 0.86 | 0.362 | 0.025 |
| Familiarity ✻ Likelihood | - | - | - | - | 0.05 | 0.34 | 0.556 | 0.010 |
| Total details | | | | | | | | |
| Familiarity | 8.75 | 1.36 | .252 | 0.040 | 0.36 | 0.20 | 0.657 | 0.006 |
| Likelihood | 11.47 | 1.64 | .210 | 0.047 | 0.12 | 0.05 | 0.823 | 0.002 |
| Familiarity ✻ Likelihood | 12.06 | 1.60 | .215 | 0.046 | 0.07 | 0.40 | 0.849 | 0.001 |

*$p < .01$

**$p < .05$

**Curriculum Vitae**

| | |
|---|---|
| **Name** | Claudia Morales Valiente |
| **Post-secondary Education and Degrees:** | The University of Western Ontario<br>London, Ontario, Canada<br>2019-present<br>Master of Science: Psychology (CDBS)<br>Thesis tittle: Familiarity and likelihood in the simulation of future events<br>Supervisor: Dr. Ken McRae |
| | University of Havana<br>Havana, Cuba<br>2008-2013<br>B.Sc.: Psychology<br>Thesis tittle: Cognitive predictors of facial recognition<br>Supervisor: Dr. Miguel Alvarez |
| **Honours and Awards:** | MITACS Research training Award<br>2020 |
| | *Suma cum laude*, Faculty of Psychology.<br>2013 |
| **Related Work Experience** | Graduate Teaching assistant<br>The University of Western Ontario<br>2019-present |
| | Instructor professor |

University of Havana
2016-2019

Undergraduate Teaching Assistant
University of Havana
2008-2013

**Publications:**

Wong, A.; Morales, C.; Mok, L.; Manzanero, A. L. & Alvarez, M. (2018). Child and Adolescent Behavior Questionnaire. An exploratory factor analysis in a sample of Cuban schoolchildren. *Psicología Educativa, 24,*14-25.

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Peña, S., Pérez, M., Morales, C., Alvarez, M. (2017). On-Skills Training for Industrial Design Students. *Revista Cubana de Educación Superior, 2,* 95-101

Morales, C., Manzanero, A.L., Gómez-Gutiérrez, M., Iglesias, A.M., Wong, A…. Alvarez, M. (2017) Stability of autobiographical memory in young people with intellectual disabilities. *Anuario de Psicología Jurídica, 27* (1), 79-84.

Alvarez, M., Morales, C., Hernández, D. R., Cruz, L. y Cervigni, M. (2015). Cognitive basis of Academic Achievement in Students from the Industrial Design field. *Arquitectura y Urbanismo, 36*(1), 86-91.

Alvarez M., Trapaga M., Morales, C. *Neuroscience Principles for Psychologists*. 2nd Edition. Paidós, Buenos Aires, 2013