

Altering Access to Autobiographical Episodes with Prior Semantic Knowledge

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RUNNING HEAD: Personal Semantics and Autobiographical Memory Access

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### **Abstract**

Within autobiographical knowledge, semantic and episodic memory are traditionally considered separate, but newer models describe them along a continuum, which raises the possibility an intermediate form of knowledge - personal semantic information. This study tested how different types of semantic— general semantics and two forms of personal semantics – impact access to personal episodic memories. In two experiments, participants made a series of true/false judgments about a prime statement reflecting a general semantic fact, a context-dependent (e.g., repeated event) or context-independent personal semantic fact (e.g., trait), and then retrieved a specific past episodic memory. There was a significantly stronger priming effect for accessing specific episodic memories after judging personal semantic facts versus general facts. We also found that context-dependent and -independent personal semantic facts have separable priming effects on episodic memory. These findings support a continuum model of memory and verifies that there are multiple forms of personal knowledge.

**Keywords:** *episodic memory, semantic memory, autobiographical memory, priming, personal semantics*

## **Introduction**

The autobiographical memory system encompasses both episodic memories, which are records of specific, personal past experiences, as well the conceptual knowledge related to these events and ourselves. Although episodic memories are the defining feature of autobiographical memory, the conceptual elements related to these memories have a considerable impact on autobiographical remembering. Decades of research have illustrated that activating conceptual information, commonly considered the domain of semantic memory, eases access to specific episodic memories by virtue of the interconnectedness of these forms of knowledge (Conway, 2001; Conway & Bekerian, 1987; Conway & Pleydell-Pearce, 2000). Within this organizational structure, there are different forms of conceptual information linked to specific autobiographical events. Here we compared how accessing different types of conceptual information affects the subsequent access to episodic memories. The overall aim of this study was to improve our understanding of how semantic and episodic memory interact within the autobiographical memory system.

## **The Organization of the Autobiographical Memory System**

Models of autobiographical memory organization propose that components of autobiographical knowledge are stored at disparate, yet interacting levels within a hierarchical structure (Barsalou, 1988; Conway, 2005). At the top of this hierarchy is conceptual knowledge, which includes general facts and beliefs about the world and the self. This type of knowledge is typically considered the domain of semantic memory. Nested within this knowledge is information about general life events (e.g. grocery shopping every week), and at the lowest level

of the hierarchy are specific episodic memories (e.g. taking your first exam in university; Barsalou, 1988; Conway, 2005). As such, successfully retrieving a specific episodic memory requires interdependency between these forms of knowledge or memory, such that activating one of these higher levels, or forms of memory, can lead to the activation of related information at a lower level (Barsalou, 1988; Conway, 2001; Conway & Bekerian, 1987; Conway & Pleydell-Pearce, 2000; Mace, 2005, 2010).

In the lab, studies have found that semantic information can affect episodic memory tests such as free recall performance (Bower et al., 1969; Howard & Kahana, 2002). In everyday memory retrieval, the ability of conceptual information to affect episodic memory retrieval is also likely to be present, for instance, retrieving a certain fact (*Jerry Seinfeld is from New York*) then leading to the retrieval of specific memory (*I saw Jerry Seinfeld at the Bell Center last July*). This notion is empirically supported by autobiographical memory research (Mace, 2006; Schlagman et al., 2008). Priming experiments have shown that conceptual information can prime access to episodic autobiographical memory. Reiser and colleagues (1985), reported that accessing concepts related to personal events (e.g., activities) can prime autobiographical memory retrieval (however, see Conway & Bekerian, 1987 for some inconsistent results). Other researchers found that non-event conceptual knowledge, such as global semantic knowledge, also can prime the retrieval of specific episodic events. In one study, participants were primed to think about general concepts (e.g., flowers) and then were given a subsequent autobiographical memory retrieval task that included these concepts as cues. Although retrieval time was not measured in this study, the researchers found that participants retrieved more memories that included the previously primed concepts (Mace, 2005, 2006, 2010, 2014; Mace et al., 2019). The assumption here is that semantic knowledge is linked to and thus can activate specific

autobiographical events (i.e., the episodic component) through connected links within a declarative memory network.

An open question is whether different forms of conceptual knowledge that pertain to an episodic autobiographical memory differentially trigger recollection of that event. More specifically, it is important to establish if there is a difference between general and personalized conceptual knowledge in priming episodic autobiographical retrieval. General conceptual knowledge is defined as global facts and information related to an autobiographical memory. Personal semantic knowledge is defined as conceptual information about the long-term self, an individual's lifetime history, beliefs and attitudes (Conway, 2005). There are some indications that activating personal knowledge is better able to improve the retrieval of related episodic autobiographical memories than general knowledge. For example, past studies have found that concepts framed as goal-directed categories (Going shopping) primed memories more than taxonomic categories (Vegetables), presumably because goal-derived categories activated a form of personal semantics that is more closely associated to episodic memory within the underlying autobiographical organizational structure (Haque & Conway, 2001). More generally, when participants attempt to retrieve episodic memories, they provide more personal than general semantic information during recall (Renoult et al., 2012, 2020).

When thinking about personal semantic information within this structure, however, it is worthwhile to consider disparate forms of personal semantics. Here we consider the distinction between context-dependent and context-independent personal semantic information. Personal semantics can be retrieved in the form of context-independent knowledge when abstracted forms of knowledge are accessed, including personal information, preferences or beliefs that are not specific to a specific time or location (e.g. I have two siblings; I take milk in my coffee; Brewer,

2011; Grilli et al., 2018; Grilli & Verfaellie, 2014; Renoult et al., 2012). In contrast, personal semantics is context-dependent when the associated information represents generalized contextual knowledge of rehearsed lifetime events, such as visiting Starbucks to get coffee on weekday mornings or attending weekly fitness classes. Context-dependent personal semantic information is considered to be more tightly associated with specific episodes than more abstracted forms of personal semantics (Renoult et al., 2012). In support, research has found similar cognitive and neural correlates for accessing repeated personal events and episodic memories (Addis et al., 2004; Brewer, 2011; Rubin et al., 2003; Rubin & Umanath, 2015). Additionally, neuropsychological conditions that affect episodic memory retrieval also affect the recall of repeated events, but not more generalized self-knowledge (St-Laurent et al., 2009; Tulving, 1993). For example, access to context-free personal semantic information, such as autobiographical facts, is often spared in medial temporal lobe (MTL) amnesia, when episodic memory is impaired (Noulhiane et al., 2007; Oxbury et al., 1997; Picard et al., 2013; St-Laurent et al., 2009; Viskontas et al., 2000). These findings and theories of autobiographical memory organization (Barsalou, 1988; Conway, 2001) would suggest that context-dependent personal semantics are organized more closely to episodic events in the hierarchy of autobiographical knowledge, and thus would serve as a better prime for episodic memory retrieval than context-independent personal information.

Finally, an important consideration is that retrieval of specific episodes that are consistent versus inconsistent with personal semantic knowledge may influence information recall (Klein et al., 2009). This is based on past research that has shown that relevant episodic memories are activated to confirm inconsistent, context-independent personal semantics, such as personality traits, are being evaluated (Babey et al., 1998; Klein et al., 2001). That is, episodic memories are

important to reflect on specific scenarios that are inconsistent with generalized personal semantic trait information, raising the possibility that accepting or rejecting a personal semantic summary may alter the ability to retrieve an episodic memory.

### **Current Study**

In the present study, we tested two hypotheses regarding the link between semantic information and episodic autobiographical memories. Our main hypothesis is that personal semantic information, as compared to general semantic information, is more strongly linked to episodic memories and thus will serve as a better prime to access specific past experiences. Testing this hypothesis would expand on priming hypotheses concerning autobiographical memory (Mace et al., 2019). A second hypothesis is that, within the context of personal semantic information, activating context-dependent personal semantics will lead to quicker retrieval of an episodic autobiographical memory than activating context-independent personal semantics. To test these hypotheses, we conducted a behavioural experiment in which participants retrieved three types of knowledge (general facts, context-independent and context-dependent personal semantics) prior to accessing an episodic autobiographical memory in response to a related cue-word. We assessed how these types of semantic knowledge are accessed and, critically, the impact on the ability to access a subsequent episodic autobiographical memory. Finally, we consider whether rejecting or accepting a personal semantic summary statement altered the ability to access an episodic memory.

### **Experiment 1**

#### **Participants**

The reported sample consisted of 26 healthy young adults (17 females; mean age = 22 years,  $SD = 2.33$ ; mean education = 16 years,  $SD = 2.45$ ) that were recruited from McGill

University. The original sample included 35 young adults, however 9 did not meet the language requirement (i.e., they learned English after the age of 10 and English was not their predominant language). All participants provided written informed consent in accordance with the code of ethics established by the McGill University ethics review board and were compensated for their time with either course credit (for students recruited from the psychology participant pool) or payment of \$10 per hour.

### **Stimuli**

Thirty-two stimuli sets were selected from a larger bank that we created. First we selected nouns from the Clark & Paivio (2004) word bank that were equated on characteristics known to affect memory (concreteness:  $M = 6.73$ ,  $SD = 0.30$ ; imageability:  $M = 6.49$ ,  $SD = 0.25$ ; frequency:  $M = 1.79$ ,  $SD = 0.24$ ; and emotion:  $M = 3.26$ ,  $SD = 0.55$ ). For each noun we then generated a related verifiable general fact, an autobiographical fact and a repeated event sentence. To create each of these sentence statements, we used the same logic as described by Renoult et al., (2016), and had each sentence end with the noun to serve as a memory cue (Appendix 1). For the general fact statements, sentences were based on dictionary entries (dictionary.com) related to the primary meaning of the cue word (e.g. “A caffeinated beverage made of roasted beans is coffee”). For the context-independent personal semantic statements, we created sentences that reflected context-free opinions about the self or general self-knowledge related to the cue word (corresponding to autobiographical facts and self-knowledge in Renoult et al.,'s (2012) taxonomy). These sentences generally began with “I enjoy”, “I prefer”, “I like”, “I own” (e.g. “I take milk in my coffee.”).

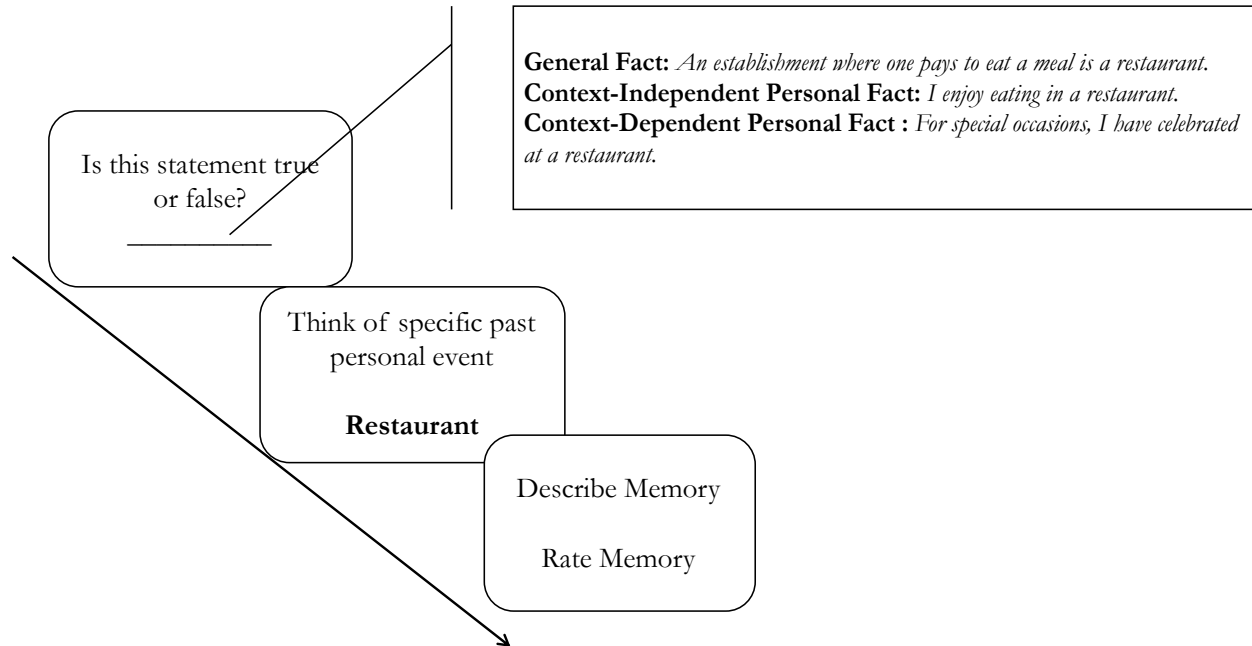
For the context-dependent personal semantic statements, we created sentences that reflected context-dependence, but still containing general information (i.e., repeatedly visiting a



location or engaging in an activity) that related to the cue word (corresponding to repeated events in Renoult et al.,'s (2012) taxonomy). These statements usually started with a spatial or temporal context phrased as "When x" or "During y", and were written in the past perfect tense ("When I go to the cafe, I have bought a cup of coffee."). For these sentences, we avoided referencing daily repeated events (e.g., When I brush my teeth, I have used toothpaste) since information about these events could be retrieved without accessing contextual semantic information.

### **Procedure**

The experiment took place in a single session and was presented via Eprime software (Version 2.0; Psychology Software Tools, Pittsburgh, PA). During this session, participants first completed 4 practice trials (one per experimental condition), followed by 32 experimental trials (8 general facts, 8 autobiographical facts, 8 repeated events and 8 controls). For each trial, participants were presented with a prime statement that represented one of the three types of semantic statements described above and were asked to verify by button press if the semantic prime statement was true or false (sentence verification). We also included eight control trials that required participants to verify if a random string of four to eight symbols (e.g., &%\$#@!) contained odd or even number. The response and reaction time (RT) to verify these sentences, or count the symbols, were recorded from the start of the sentence presentation to when the response was made, which differs from typical sentence verification RT data collection (Chang, 1986). All prime statements remained on the screen until a response was made.



**Figure 1.**

*A schematic of an experimental trial. Participants first saw a semantic prime statement (8 per condition) and responded true or false to these statements (sentence verification). The last word of that statement remained on the screen and participants were asked to retrieve a specific past personal event to that word as quickly as possible (cued memory retrieval). Reaction time was measured. The trial ended with participants describing the memory and rating the memory on a series of dimensions.*

Following semantic priming, the associated cue word (i.e., the final word of the statement) appeared on the computer screen and participants were instructed to use this cue to retrieve a specific episodic autobiographical memory. They were told a specific memory was a single event that happened to them and that must be an event for which they can remember where and when it occurred. Once they had this memory in mind, they were asked to verbally

indicate when it was accessed (say “GO”) and we recorded this response time. Participants then described the accessed memory in one or two sentences and indicated the date of the memory on a categorical scale (this week, this month, this year, few years ago, about ten years ago, over ten years, don’t know). Participants then rated their recall on scales of vividness [1 (vague recall with few details) to 7 (as if it was mentally reexperienced)], emotional valence [positive, neutral, negative], emotional intensity [1 (mild) to 7 (very intense)] and importance [i.e., how life changing was this event; 1 (This is a trivial event) to 7 (This is a life changing event)]. The sentence descriptions were later scored as either specific or non-specific autobiographical events using the Autobiographical Memory Test scoring procedure (AMT; Williams & Broadbent, 1986). Specific events are those describing personal experiences from one place and during a defined time period (e.g., “*going to the country fair with my husband Alan last weekend*”). All other responses were coded as non-specific memories.

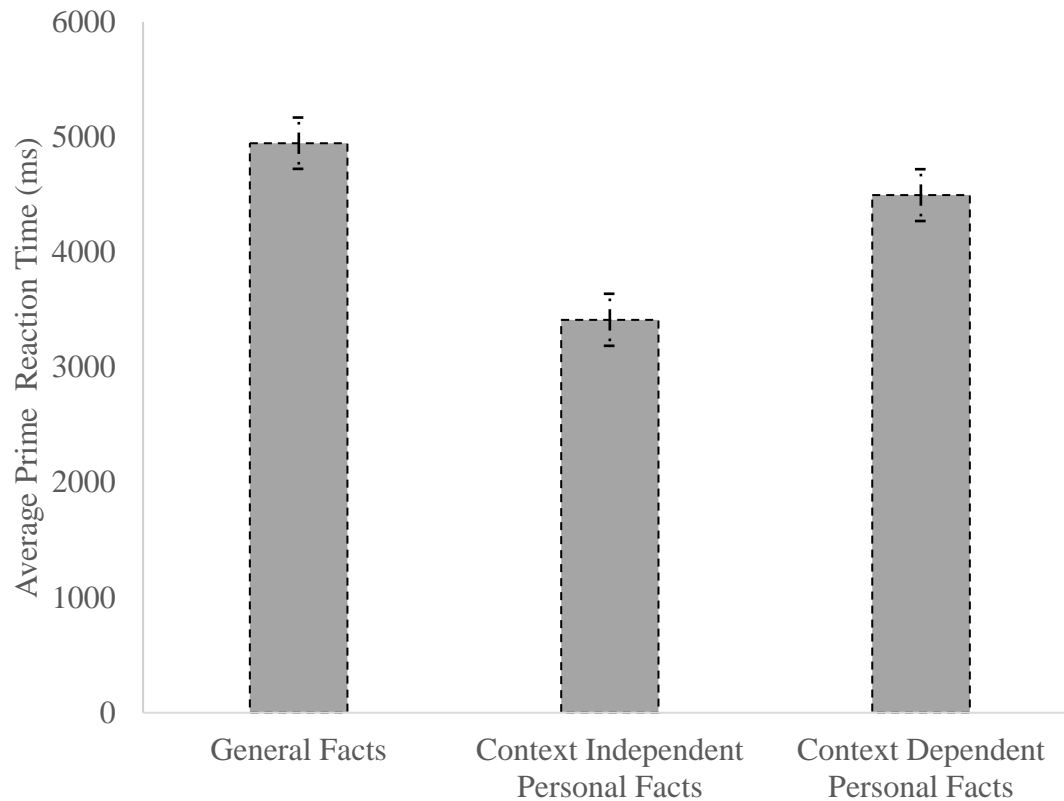
### **Data Analysis**

Prior to analysis, we excluded all the trials that did not accurately represent the participant’s retrieval time due to error in response collection ( $n = 51$  trials across all participants) as well as outlier trials (RT > 2 standard deviations above the participant mean response time,  $n = 47$  trials). We constructed a series of general regression or linear mixed effects models with the response variable of interest as the dependent variable, condition as a fixed factor and subject as a random variable. Regression coefficients and  $p$ -values were based on Satterthwaite approximations for denominator degrees of freedom, established using the ‘lme’ test via the GAMLj function in Jamovi (version 0.9.5.12). Post-hoc comparisons were based on effect estimates and standard errors from the analyzed models.

## Results

### Semantic prime statement responses

The linear mixed model constructed to determine if the reaction time to answer the prime statements differed as a function of prime condition (general, context-independent personal and context-dependent personal facts) and type of response given (true or false) were included the natural log of the reaction time as the dependent variable (n.b., figures and reported means depict average response rates for illustrative purposes) and subject as a random intercept (reaction time  $\sim 1 + \text{condition} + \text{response} + \text{condition} * \text{response} + (1 | \text{subject})$ ). The results demonstrated a significant effect of prime condition ( $F_{(2,583)} = 65.56, p < .001$ ), and response-type ( $F_{(1, 587)} = 10.93, p < .001$ ), but no significant interaction between the two ( $F_{(2, 589)} = 0.321, p = 0.73$ ). Participants were faster when responding “true” ( $M = 4090$  ms,  $SE = 209$  ms) than when responding “false” to the statements ( $M = 4481$  ms,  $SE = 218$  ms;  $\beta = .089$ ;  $SE = 0.04$ ;  $t_{(587)} = 3.306, p < .001$ ). Participants were also faster to respond to context-independent personal semantic prime statements than general fact prime statements ( $\beta = .36$ ;  $SE = 0.03$ ;  $t_{(582.5)} = 11.00, p < .001$ ) as well as context-dependent personal semantic prime statements ( $\beta = .28$ ;  $SE = 0.03$ ;  $t_{(583.1)} = 8.46, p < .001$ ), and were faster to context-dependent personal than general fact statements ( $\beta = .078$ ;  $SE = 0.03$ ;  $t_{(587.7)} = 2.43, p = .016$ ). These effects are illustrated in Figure 2.



**Figure 2.**

*The average reaction time in milliseconds (standard error bars shown) to answer the prime statements (true versus false) as a function of condition.*

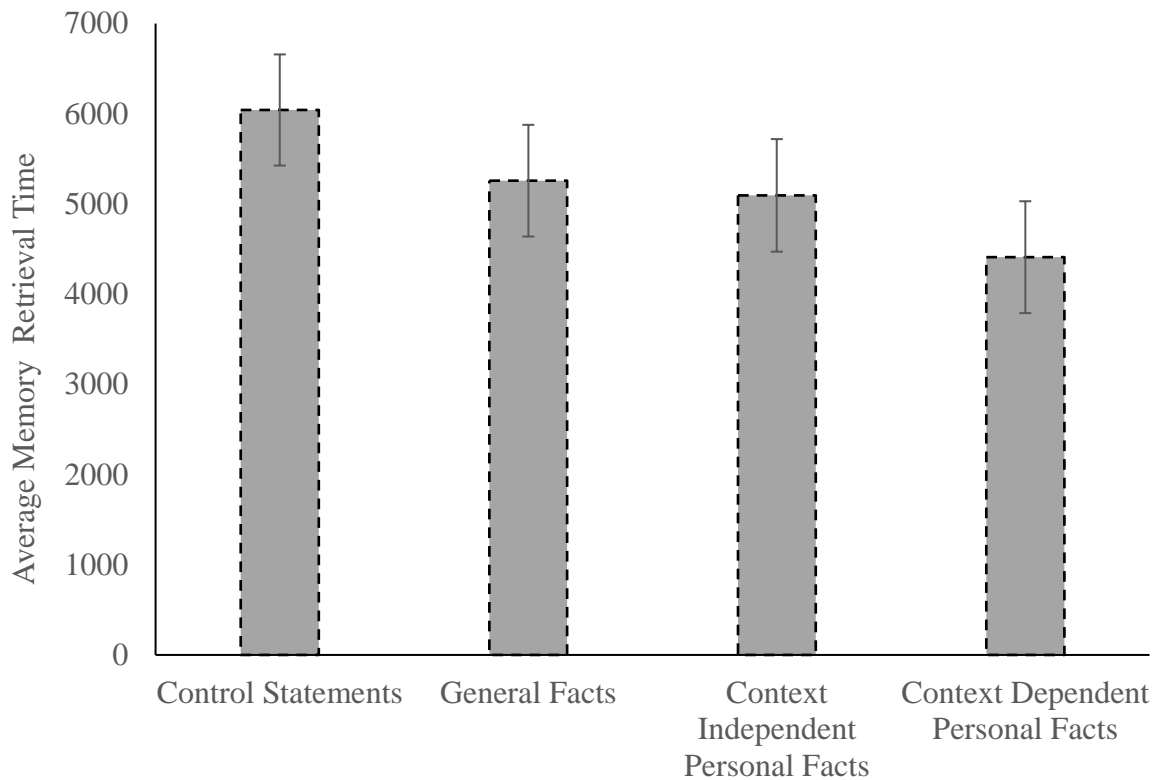
### **Episodic autobiographical memory retrieval**

The primed autobiographical memory descriptions were first scored as a specific or non-specific autobiographical event, and a logistic generalized linear model was run to determine if prime condition or prime response affected the likelihood of generating a specific memory. The likelihood ratio test revealed that neither condition ( $X^2(2) = 1.21, p = .54$ ), response-type ( $X^2(1) = 0.75, p = .39$ ), nor the interaction of these variables ( $X^2(2) = 0.07, p = .97$ ) determined whether a specific memory was generated.

The next analysis examined if the retrieval time to access specific memories differed as a function of condition. Here, we included semantic prime statements to which participants gave a true response, indicating the associated personal knowledge was being accessed, as well as the control condition as the comparison for the experimental conditions' memory retrieval time.

A linear mixed effects model was constructed to predict the natural log of the retrieval time to access a specific memory. We included prime condition, prime response-type and the reaction time to the prime statement as fixed factors, as well as subject as a random variable (retrieval time  $\sim 1 + \text{condition} + \text{prime response} + \text{condition} * \text{prime response} + \text{prime reaction time} + (1|\text{subject})$ ). Results indicated that both prime condition ( $F_{(3,619)} = 9.59, p < .001$ ), and prime response-type ( $F_{(3,619)} = 16.30, p < .001$ ) were significant predictors of memory access time. Neither the prime response time ( $F_{(1,635)} = 3.33, p = .13$ ) nor the interaction between prime condition and prime response-type ( $F_{(3,620)} = 1.60, p = .188$ ) were significant predictors.

Focusing on the prime condition effect, comparisons revealed that all the experimental prime conditions facilitated faster access to specific memories than the control task (general facts:  $\beta = .14; SE = 0.06; t_{(619.3)} = 2.44, p = .01$ ; context-independent personal facts:  $\beta = .22; SE = 0.07; t_{(617.6)} = 3.95, p < .001$ ; context-dependent personal facts:  $\beta = .29; SE = 0.06; t_{(618.2)} = 4.95, p < .001$ ). Amongst the experimental prime conditions, context-dependent personal facts led to faster episodic access than general facts ( $\beta = .15; SE = 0.06; t_{(617.4)} = 2.58, p = .01$ ), however there was no difference between the general facts and context-independent personal fact conditions ( $\beta = .082; SE = 0.06; t_{(621.6)} = 1.36, p = .18$ ) nor was there a difference in speed of episodic access following priming with context-dependent or -independent personal facts ( $\beta = .06; SE = 0.06; t_{(620.2)} = 1.06, p = .29$ ).



**Figure 3.**

*The average reaction time in milliseconds (standard error bars shown) to retrieve a specific episodic memory as a function of condition.*

Finally, to investigate if the experience of autobiographical remembering varied as function of the prime condition, we entered the collected memory ratings into separate linear mixed models with condition as a fixed factor along with (natural log) retrieval time, and subject as a random variable. Focusing on the condition effects, there was a significant effect on emotion ratings ( $F_{(3,121)} = 3.54, p = .01$ ), such that specific memories primed with context-independent personal facts were more positive than those primed with context-dependent personal facts, with no other comparison reaching significance. The prime condition effect for vividness was also significant ( $F_{(3,122.4)} = 3.54, p = .01$ ) and showed that specific memories primed with context-

dependent personal facts were more vivid compared to those retrieved in the control condition. The prime condition effect for memory intensity was not significant ( $F_{(3,122)} = 1.97, p = .12$ ), nor was it for importance ( $F_{(3,123)} = .68, p = .16$ ). See Table 2 for the average responses in each condition.

**Table 2.**

*Average ratings across prime condition to memories retrieved following a positively endorsed prime statement. The symbols illustrate the comparisons that are significantly different for the ratings. \* indicates the conditions that were significantly different ( $p < .05$ ) from one another.*

Rating	General facts	Context-independent personal facts	Context-dependent personal facts	Control
<b>Valence</b> (/3)	1.71 (.14)	1.48 (.05)*	1.89 (.144)*	1.60 (.15)
<b>Vividness</b> (/7)	4.62 (.303)	5.18 (.302)	5.37 (.304) *	4.39 (.326) *
<b>Intensity</b> (/7)	3.59 (.37)	3.88 (.37)	4.50 (.398)	4.05 (.375)
<b>Importance</b> (/7)	3.07 (.343)	2.72 (.341)	3.25 (.344)	3.23 (.373)

### Interim Discussion

We found evidence that forms of personal semantics are organized differently from general semantics, such that context-dependent personal facts are accessed more quickly and thus are presumed to be more tightly associated with specific episodic memories than general facts. These findings provide new insight into the organization of information in long-term memory, particularly autobiographical memory. However, before delving into these insights, we ran a second experiment to address some of the methodological limitations of Experiment 1. First, retrieval time to access a memory was assessed by a verbal response in Experiment 1, which introduces measurement variability. Second, participants retrieved specific memories in



response to a cue word that was embedded within the preceding prime statement. This made it unclear if the subsequently retrieved specific memory was related to the primed conceptual knowledge or a product of the stand-alone cue word. In Experiment 2, we revised how reaction time was captured during episodic memory retrieval, opting for a button press rather than the verbal response used in Experiment 1, and had participants retrieve memories to the prime statements rather than stand-alone word cues. We also included more trials so we could accurately compare differences between prime response-type (i.e., whether a given prime statement was endorsed as “true” or “false”), which could not be addressed in Experiment 1 due to the limited number of trials per prime condition ( $n = 8$ ). As reviewed in the introductory section of this paper, past research has proposed that specific events (episodic memories) are activated to serve as a boundary for context-independent personal semantic information (Klein & Loftus, 1993; Klein et al., 2001, 2009; Renoult et al., 2012), which would suggest that rejecting (responding false) or accepting (responding true) generalized information might change the ease of episodic memory retrieval. We aimed to test this hypothesis in Experiment 2.

## Experiment 2

### Participants.

The reported sample consisted of 22 healthy young adults (20 females; mean age = 20 years,  $SD = 1.20$ ; mean education = 15 years,  $SD = 1.32$ ) that were fluent in English (learned before the age of 10) and were recruited from McGill University. All participants provided written informed consent in accordance with the code of ethics established by the McGill University ethics review board and were compensated for their time with course credit.

### **Stimuli and Procedure**

From a stimulus set similar to Experiment 1 (Appendix 2), participants completed 3 practice trials (one per semantic prime condition), followed by 36 experimental trials (12 general facts, 12 autobiographical facts, 12 repeated events). A control condition was not included in this experiment because priming with the control task included in Experiment 1 does not involve access to conceptual autobiographical information. As such, it was not required to address our aim of comparing the effect of prime statement response-type and prime condition on episodic memory access. Across the trials, participants were presented with a randomly selected semantic prime statement from one of the three conditions and verified via button press whether the statement was true or false. Following this response, participants were asked to recall a specific past personal memory to that previous statement and to indicate by button press when that event was in mind. As in Experiment 1, they were told a specific memory was an event that happened to them personally and for which they could remember where and when it occurred. During practice trials, they were corrected if a non-specific response was given. After making the button press, participants described out loud the accessed memory in one or two sentences and indicated the date of the memory on a categorical scale (this week, this month, this year, few years ago, about ten years ago, over ten years, don't know), the vividness (1 [vague recall with few details] to 7 [as if it was mentally reexperienced]), emotional valence (positive, neutral, negative), and emotional intensity (1 [mild] to 7 [very intense]) of the memory.

## Results

### Semantic Prime Statement

A linear mixed model to predict the (natural log) reaction time to answer the semantic prime statements indicated that prime condition and prime response-type (true or false) were both significant predictors ( $F_{(2,716)} = 20.30, p < .001$  and  $F_{(1,723)} = 4.91, p = .030$ ), but not the interaction between these terms ( $F_{(1,717)} = .52, p = .59$ ). Across conditions, true responses ( $M = 7516$  ms,  $SE = 203$  ms) were made faster than false responses ( $M = 8425$  ms,  $SE = 309$  ms;  $\beta = .07$ ;  $SE = 0.031$ ;  $t_{(723.1)} = 2.22, p = .03$ ). Similar to Experiment 1, context-independent personal facts ( $M = 7026$  ms,  $SE = 308$  ms) were responded to more quickly than general facts ( $M = 8350$  ms,  $SE = 280$  ms) and context-dependent personal facts ( $M = 8172$  ms,  $SE = 299$  ms;  $\beta = .20$ ;  $SE = 0.04$ ;  $t_{(715.9)} = 5.68, p < .001$ ;  $\beta = .20$ ;  $SE = 0.037$ ;  $t_{(715.4)} = 5.40, p < .001$ ), but there was no difference between the latter two ( $\beta = .0004$ ;  $SE = 0.04$ ;  $t_{(715.8)} = .12, p = .91$ ).

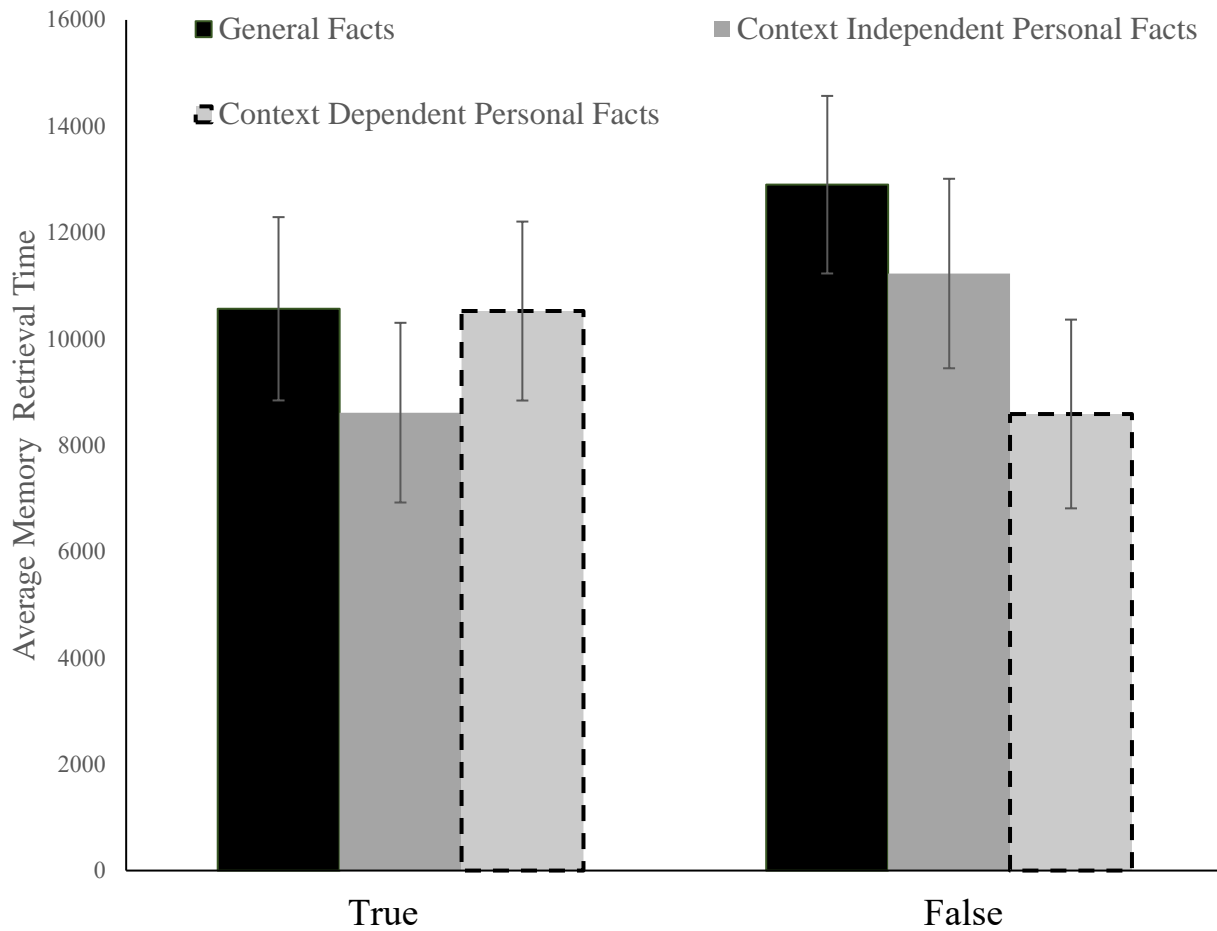
### Episodic Autobiographical Memory Retrieval

After scoring the descriptions of retrieved autobiographical memories as specific or non-specific, we ran a logistic generalized linear model to determine if prime condition or prime response-type affected the likelihood of generating a specific memory. Much like Experiment 1, results revealed that neither prime condition ( $X^2(2) = 2.36, p = .31$ ), nor response-type ( $X^2(1) = 1.38, p = .24$ ) impacted the likelihood of a specific memory being retrieved, nor did the interaction between these variables ( $X^2(2) = 1.91, p = .38$ ).

To examine if reaction time to access these specific memories differed as a function of prime condition and prime response-type, we ran a linear mixed model to predict the (natural

log) reaction time to retrieve a specific memory. Results indicated that both prime condition and response-type (true or false) were significant predictors ( $F_{(2,715)} = 11.33, p < .001$  and  $F_{(1,718)} = 7.04, p = .008$ ), but not prime reaction time ( $F_{(1,730)} = 1.70, p = .19$ ). Critically, the interaction between prime condition and prime response-type was significant ( $F_{(2,716)} = 4.93, p = .006$ ), which differs from Experiment 1.

To unpack the interaction effect, we ran separate linear models for the true and false prime response-types. For statements receiving a true response (Figure 4, right panel), indicating that the primed statement was part of the participants autobiographical knowledge, we found a significant prime condition effect ( $F_{(2,447)} = 4.17, p = .016$ ). This effect was driven by faster access to specific memories when retrieval was primed with context-dependent facts as compared to both context-independent personal facts ( $\beta = .22; SE = 0.86; t_{(446.9)} = 2.52, p = .012$ ) and general facts ( $\beta = .211; SE = 0.09; t_{(446.9)} = 2.38, p = .018$ ). However, there was no difference between the autobiographical and general fact priming conditions ( $\beta = .006; SE = 0.09; t_{(448.0)} = 0.06, p = .95$ ) in their ability to facilitate subsequent retrieval of specific autobiographical episodes.

**Figure 4.**

*The average reaction time in milliseconds (standard error bars shown) to access specific episodic memories as a function of prime condition and prime response-type*

For statements receiving a false response (Figure 4, right panel), the prime condition effect was also significant ( $F_{(2,249)} = 12.68, p < .001$ ). This was driven by slower access to specific memories when primed with general facts as compared to both context-independent ( $\beta = .48; SE = 0.10; t_{(249.7)} = 4.77, p < .001$ ) and content-dependent personal facts ( $\beta = .34; SE = 0.10; t_{(249.0)} = 3.46, p < .001$ ). However, there was no significant difference in speed to access specific

episodes between the context-dependant and context-independent personal semantic priming conditions ( $\beta = .137$ ;  $SE = 0.107$ ;  $t_{(249.1)} = 1.279$ ,  $p = 2.02$ ).

Finally, the linear mixed models run with subjective ratings of retrieved memories as the predicted variable, with prime condition and prime response-type as fixed factors and subject as a random factor, indicated that only emotional valence differed as a function of response-type (Table 3). Across prime conditions, participants retrieved memories that were more negative when responding to false prime statements ( $M = 1.85$ ,  $SE = .05$ ) than to true prime statements ( $M = 1.58$ ,  $SE = .036$ ).

**Table 3**

*Estimates and significance of main and interaction effects in mixed models to predict memory ratings.*

<b>Rating</b>	<b>Condition</b>	<b>Response</b>	<b>Condition* Response</b>
<b>Valence (/3)</b>	$F_{(2,718)} = 1.27$ , $p = .28$	$F_{(1,736)} = 21.20$ , $p < .001$	$F_{(2,718)} = 1.27$ , $p = .28$
<b>Vividness (/7)</b>	$F_{(2,716)} = 2.52$ , $p = .08$	$F_{(1,726)} = 3.66$ , $p = .05$	$F_{(2,718)} = 0.79$ , $p = .45$
<b>Intensity (/7)</b>	$F_{(2,716)} = 1.19$ , $p = .30$	$F_{(1,725)} = 2.09$ , $p = .15$	$F_{(2,718)} = 0.41$ $p = .47$
<b>Date (/6)</b>	$F_{(2,716)} = 0.07$ , $p = .94$	$F_{(1,730)} = 0.013$ $p = .91$	$F_{(2,720)} = 0.52$ $p = .59$

## General Discussion

Traditional and contemporary findings in memory research have highlighted the interdependence between the semantic and episodic systems, particularly during autobiographical recollection tasks (for a review, see Greenberg & Verfaellie, 2010). Among these findings are behavioural studies that have shown that activating general semantic concepts can affect episodic autobiographical memory retrieval, potentially serving as a prime for accessing unique life episodes (Mace, 2005, 2006, 2010, 2014; Mace et al., 2019). Following these findings, the current study provides new insights into how a particular form of semantic knowledge – personal semantics – interacts with episodic memory within the domain of autobiographical recall. Our study provides new evidence that personal semantics is more tightly associated with episodic memory than general semantics, and further demonstrates a division within this personal semantic category. This division, established when comparing the priming effects on accessing unique episodic memories from context-dependent and -independent forms of personal knowledge, indicates that personal semantic information that is tied to contextual information is more strongly associated with episodic memory than more abstracted personal semantic concepts. This finding supports, broadly, the importance of semantic memory in driving episodic memory recall (Irish & Piguet, 2013) and, specifically, the theory that personal semantics is a distinct form of conceptual knowledge that varies in how closely it is represented to unique episodic memories within an organizational structure of memory (Renoult et al., 2012).

Prior research has examined how aspects of semantic memory interact with the episodic memory on a variety of tasks to indicate the bi-directional influences these components have on one another. As one example, a series of reports indicated improved performance on semantic

memory tests for famous names that were judged to be autobiographically significant – containing an episodic memory component – compared to those that were less autobiographically significant (Renoult et al., 2016; Westmacott et al., 2001; Westmacott et al., 2004; Westmacott & Moscovitch, 2003). As another example, research has shown that when learning a list of items, semantically similar items are more likely to be later recalled as a group than semantically dissimilar items, suggesting that semantic memory organizes episodic memory retrieval (Bower et al., 1969; Howard & Kahana, 2002).

Within the realm of autobiographical memory retrieval, the utility of semantic memory in organizing the retrieval of unique personal episodes has been illustrated by studies using priming paradigms. These studies have shown that cueing relevant “semantic” content pertaining to the self (e.g., lifetime periods or general themes) can facilitate the access of specific memories (Conway & Bekerian, 1987; see Ball & Hennessey, 2009, for a related example that used subliminal priming). More recent data indicate that general semantic information that is not autobiographical *per se* (e.g., category concepts) can also prime episodic autobiographical memory access (Mace et al., 2019), indicating that general and autobiographical long-term knowledge are not independently organized. An earlier view suggested that these data are evidence for a hierarchical model of autobiographical information storage, such that specific memories are stored within (i.e., at a lower level than) conceptual information about the self (Conway, 2005). More generally, these data are evidence that semantic and episodic memory are much more interactive in how they are organized in long term memory, which has led to the proposal that there is a form of knowledge that emerges from the interaction of these systems, which is personal semantic knowledge (Renoult et al. 2012).



Our data illustrate how personal semantic knowledge – which is at the “cross-roads” between semantic and episodic memory interactions – affects (i.e., primes) episodic autobiographical memory retrieval differently than general semantic knowledge. We interpret these data as evidence for newer continuum or gradient models of autobiographical knowledge organization in which semantic and episodic memory are represented within the same system rather than as distinct entities (Renoult et al., 2012). These models posit that there is a continuum from concrete/contextual to abstract representation of information that represents the traditional episodic and semantic memory dichotomy. Where along the continuum information is accessed will determine how that information is represented – abstractly or contextually – and this will activate different underlying mechanisms (Irish & Vatansever, 2020).

More specifically, we show that activating semantic information closer to the contextual end of the continuum – near traditionally defined episodic memory – serves as a stronger prime for accessing unique personal memories than more abstracted personal semantic knowledge (e.g., trait information) or general facts. Generally, this suggests that context information embedded in personal semantic memory requires information retrieved other than personal semantic information that is not tied to a context. This finding explains why prior work has found that context-dependent personal semantic information (places typically visited) requires different neural processes than accessing generalized self-knowledge, such as personality traits and autobiographical facts (Noulhiane et al., 2007; Oxbury et al., 1997; Picard et al., 2013; St-Laurent et al., 2009; Viskontas et al., 2000). It could also be that context-dependent personal semantic information represents information that has yet to transform to general abstracted facts, and thus is information that is in the process of transforming from a specific event to a general fact (Moscovitch et al., 2016; Winocur & Moscovitch, 2011; Renoult et al., 2016). That is, when

context is included as a detail pertaining to concept knowledge, then extracted information is more closely aligned to episodic memory. This supports the reported overlap between retrieving repeated event information and episodic memory (Addis et al., 2004; Burianova & Grady, 2007; Holland et al., 2011; Levine, 2004; Rubin & Umanath, 2015; St-Laurent et al., 2009). In considering this priming effect, however, it is important to consider the possibility that episodic memories were triggered during verification of the prime statement rather than when cued to retrieve that memory. This possibility would suggest that an episodic memory is more likely to be used to verify a semantic fact when that fact is tied to a context than when it is not, and fits with the notion that episodic and semantic aspects of autobiographical memory are retrieved as a function of a person's current retrieval goals (Conway & Plyedell-Pearce, 2000).

We also found different patterns of episodic memory priming when participants endorsed or rejected the general or personal fact prime statement. Klein and colleagues (2002, 2004) have proposed that one function of episodic memory is to reflect specific examples of personal semantic (i.e., trait) information. According to the Scope Hypothesis (Klein, 2009), these memories serve as boundaries for generalized semantic information that is stored at a more abstracted level. This hypothesis predicts that episodic memories will be most easily retrieved when inconsistent personal semantic information is being evaluated. In general, we did find that specific memories were more quickly accessed following inconsistent (false) personal semantic prime statements compared to inconsistent (false) general semantic prime statements (right panel, Figure 4). However, our data do not support this hypothesis. Indeed, when participants indicated that a particular semantic prime statement was false (inconsistent; saying "no" to the statement "I take milk in my coffee", reminding a person of a memory of disliking milk in coffee), subsequent specific memories were accessed more slowly than when a semantic prime

statement was endorsed as true (consistent). Thus, we suggest that when evaluating a generalized personal statement as false, a specific behavioural episode might be brought to mind to verify the validity of that evaluation. This interpretation speaks to the potential evaluative functions of episodic memory for understanding the self. To directly test this interpretation, a future study may wish to ask participants to retrieve consistent versus inconsistent specific memories (for an example, see Hitchcock et al., 2017).

Interestingly, when we examined the time to verify prime statements (context-dependent or -independent personal facts as well as general facts). We found that verifying abstracted personal semantic (context-independent) information was quicker than verifying context-dependent personal semantic statements or general facts. It should be noted that the reaction time to verify these sentences collected in this study are longer than those typically reported (see Chang, 1986) and this is because we measured time from when the participant began reading the sentence to when their response was made. Typically, reaction time to verify these sentences are captured from the offset of the sentence to when the response is made. Nevertheless, our data suggest that personal semantic information free of context is easier to access, and possibly more familiar, than other forms of long-term content. Together, these findings illustrate easier initial access to context-independent personal facts with a weaker episodic memory priming compared to context-dependent personal facts indicates that this form of knowledge is represented closer to the abstracted or "semantic" end of the proposed long-term memory continuum.

### **Conclusions**

This study contributes to research examining how components of autobiographical memory are access and organized, focusing on elucidating the status of a personal semantic component. The

data presented indicate, first, that personal semantics is accessed differently than general semantic content, and second, when these forms of content are retrieved, they have different effects on episodic memory retrieval. In addition, this study provides evidence that the presence of contextual information within a semantic statement will amplify access to an episodic memory. Together, these results support a new view of memory that proposes an organizational gradient of long-term memory in which information is represented by varying degrees of episodic and semantic content.

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**Appendices**

**Appendix 1**

The list of sentences from each of the experimental conditions pertaining to a given cue word used in Experiment 1.

<b>Cue ID</b>	<b>Context Independent Fact</b>	<b>Context Dependent Fact</b>	<b>True General Fact</b>	<b>False General Fact</b>
House	I prefer a brick to a wooden house	On weekends, I have cleaned my house.	People live together in a house.	Farm animals live together in a house.
Sea	I find it easy to relax at the sea	For summer vacations, I have visited the sea	A large body of saltwater is the sea	A large body of fresh water is the sea
Horse	I know how to ride a horse	When I have driven in the country, I have seen horses	A domesticated mammal you can ride is a horse	A domesticated mammal that lays eggs is a horse
Book	I enjoy reading hardcover books	On rainy afternoons, I have read a book	Pages are bound together to make a book	Fabric is bound together to make a book
Letter	I enjoy receiving letters	Several times a year, I have mailed a letter	One written method of communication is a letter	One spoken method of communication is a letter
River	I enjoy swimming in a river	During summer months, I have swum in a river	Flowing water defines a river	Stagnant water defines a river
Bird	I enjoy watching birds	When I have walked around town, I have heard the sound of birds	Feathered animals that fly are birds	Scaled animals that fly are birds
Flower	I enjoy the smell of fresh flowers.	For special occasions, I have sent a family member flowers	The seed bearing part of a plant is a flower	The stem of a plant is a flower
Building	I prefer modern to classic buildings	When walking in a city, I have paid attention to the	A large enclosed structure with a roof, windows and	A small enclosed structure with legs and many

		architecture of the buildings.	many floors is a building.	drawers is a building. A plot of concrete where games are played is a garden A natural depression of the earth's surface is a mountain A geographic area covered with sand is a forest
Garden	I find it soothing to work in a garden	Many times, I have planted seeds in a garden.	A plot of land where flowers and food are grown is a garden A natural elevation of the earth's surface is a mountain	A plot of concrete where games are played is a garden A natural depression of the earth's surface is a mountain A geographic area covered with sand is a forest
Mountain	I enjoy walking up mountains	When on hikes, I have climbed to the top of a mountain.		A geographic area covered with sand is a forest
Forest	I enjoy being in the forest	When I have gone for a walk or jog, I have gone to the forest.	A geographic area covered with trees is a forest	A venue for relaxation and pampering is a market
Market	I prefer to buy food at the farmers market	When I have needed groceries during the week, I have shopped at the local market	A venue for the purchase and sale of different products is a market	A substance used to make food sweet is sugar Bright points that form constellations in the night sky are stars
Sugar	I eat too much sugar	When I have baked, I have used sugar	A substance used to make food sweet is sugar	A substance used to make food spicy is sugar Fluffy white objects that move across the day sky are stars.
Star	I enjoy looking at the stars	At night, I have sat outside to look at the stars.	Bright points that form constellations in the night sky are stars	
Shoes	I enjoy shopping for shoes	A few times during the year, I have bought new shoes When I have purchased items at the corner store, I have payed with coins.	Coverings for the feet are shoes	Coverings for the hands are shoes
Coin	I prefer bills to coins	When I hung frames on my walls, I have used a hammer When I have been worried about being late, I have looked at a clock	A piece of metal used as money is a coin	A piece of paper used as money is a coin A tool used to cut wood is a hammer
Hammer	I own a hammer	When I hung frames on my walls, I have used a hammer When I have been worried about being late, I have looked at a clock	A tool used to drive in nails is a hammer An instrument for measuring and recording time is a clock.	A tool used to cut wood is a hammer An instrument for measuring and recording sound is a clock.
Clock	I know how to read a clock	When spring cleaning, I have rearranged the furniture	Large movable object found in a house or office are furniture	Large movable objects found on the road are furniture
Furniture	I like vintage furniture			

Coffee	I take milk in my coffee.	When I have needed to wake up, I have bought a cup of coffee	A caffeinated beverage made of roasted beans is coffee.	A caffeinated beverage made of infused leaves is coffee. An establishment that contains music to be purchased is a library.
Library	I enjoy visiting the library	On weekends, I have visited libraries.	An establishment that contains books to be borrowed is a library.	A piece of cloth covering a dinner table is a flag
Flag	I feel patriotic when I see a flag	When I visited new places, I have noticed flags	A piece of cloth symbolizing a nation or state is a flag	
Pepper	I prefer food seasoned with pepper	When eating at restaurants, I have seasoned my meal with pepper.	A hot-tasting spice is pepper	A salty-tasting spice is pepper
Clothing	I have many items of clothing	Once or so per year, I have donated items of clothing	Items worn to cover the body are clothing	Items used to set the table are clothing
Pudding	I like eating pudding	When grocery shopping, I have often bought pudding	A creamy sweet desert defines pudding	A crunchy savory desert defines pudding
Hotel	I enjoy sleeping in hotels	When I have traveled, I have slept in a hotel	An establishment where one pays to sleep is a hotel	An establishment where one pays to watch a movie is a hotel
Stain	I have clothes with many stains	When I have worn a white shirt, I have gotten a stain	Dirty marks that are difficult to remove are stains	Crumbs that are easy to brush away are stains.
Toy	I have enjoyed playing with toys	When buying presents for children, I have often gotten a toy.	An object designed for playtime is a toy	An object designed for eating food is a toy
Candy	I prefer soft over hard candy	On Halloween, I have bought candy	A sweet food made of sugar or syrup defines a candy.	A bitter food made of flour or sauce defines a candy.
Restaurant	I enjoy eating in restaurants	For special occasions, I have celebrated at a restaurant	An establishment where one pays to eat a meal is a restaurant.	An establishment where one pays to sleep the night is a restaurant.
Lemon	I enjoy the sour taste of a lemon	When drinking certain beverages, I	A yellow oval acidic fruit is a lemon.	A small round blue fruit is a lemon.



have added a slice of  
lemon

## Appendix 2

The list of sentences from each of the experimental conditions used in Experiment 2

Cue ID	Context Independent Fact	Context Dependent Fact	True General Fact	False General Fact
Sugar	I prefer food that tastes of salt over sugar	When I have baked, I have used sugar	A substance used to make food sweet is sugar	A substance used to make food spicy is sugar
Hammer	I like using tools like a hammer	When I hung frames on my walls, I have used a hammer	A tool used to drive in nails is a hammer	A tool used to cut wood is a hammer
Clock	I prefer to use a watch than my phone's clock	When I have been worried about being late, I have looked at a clock	An instrument for measuring and recording time is a clock.	An instrument for measuring and recording sound is a clock.
Coffee	In terms of hot beverages, I prefer tea over coffee.	When I have needed to wake up, I have bought a cup of coffee	A caffeinated beverage made of roasted beans is coffee.	A caffeinated beverage made of infused leaves is coffee.
Clothing	I like to wear fancy clothing	When I go shopping, it is to get new clothing	Items worn to cover the body are clothing	Items used to set the table are clothing
House	I prefer a brick to a wooden house	On weekends, I have cleaned my house.	People live together in a house.	Farm animals live together in a house.
Book	I enjoy reading hardcover books	On rainy afternoons, I have read a book	Pages are bound together to make a book	Fabric is bound together to make a book
Letter	I enjoy receiving letters	Several times a year, I have mailed a letter	One written method of communication is a letter	One spoken method of communication is a letter
River	I enjoy swimming in a river	During summer months, I have swam in a river	Flowing water defines a river	Stagnant water defines a river

Bird	I enjoy watching birds	When I have walked around town, I have heard the sound of birds	Feathered animals that fly are birds	Scaled animals that fly are birds
Grass	I enjoy walking barefoot in the grass	At outdoor events, I have played games on the grass	A small plant, which forms a lawn is grass.	A small plant, which forms a driveway is grass.
Flower	I enjoy the smell of fresh flowers	For special occasions, I have sent a family member flowers	The seed bearing part of a plant is a flower	The stem of a plant is a flower
Building	I prefer the look of modern to classic buildings	When walking in a city, I have paid attention to the architecture of the buildings.	A large enclosed structure with a roof, windows and many floors is a building.	A small enclosed structure with legs and many drawers is a building.
Garden	I find it soothing to work in a garden	Many times, I have planted seeds in a garden.	A plot of land where flowers and food are grown is a garden	A plot of concrete where games are played is a garden
Picture	I prefer using a phone over a camera to take pictures	After I have been on a trip, I have shown my friends and family pictures	A visual representation of a scene, object or person is a picture	An auditory representation of a scene, object or person is a picture
Mountain	I enjoy walking up mountains	When on hikes, I have climbed mountains	A natural elevation of the earth's surface is a mountain	A natural depression of the earth's surface is a mountain
Sky	I prefer the blue to the grey sky	When at the park, I have laid back to look at the sky	The atmosphere surrounding the earth is the sky	The aura surrounding the sun is the sky.
Market	I prefer to buy food at the farmers market	When I have needed groceries during the week, I have shopped at the local market	A venue for the purchase and sale of different products is a market	A venue for relaxation and pampering is a market
Star	I enjoy looking at the stars	At night, I have sat outside to look at the stars.	Bright points that form constellations in the night sky are stars	Fluffy white objects that move across the day sky are stars.
Cat	I prefer dogs to cats	When walking in my neighborhood, I have seen cats	A small furry domesticated carnivore is a cat	A small scaley domesticated herbivore is a cat
Shoes	I enjoy shopping for shoes	A few times during the year, I have bought new shoes	Coverings for the feet are shoes	Coverings for the hands are shoes

Coin	I prefer bills to coins	When I have purchased items at the corner store, I have paid with coins.	A piece of metal used as money is a coin	A piece of paper used as money is a coin
Furniture	I like vintage furniture	When spring cleaning, I have rearranged the furniture	Large movable objects found in a house or office are furniture	Large movable objects found on the road are furniture
Flag	I feel patriotic when I see a flag	When I visited new places, I have noticed flags	A piece of cloth symbolizing a nation or state is a flag	A piece of cloth covering a dinner table is a flag
Pepper	I prefer food seasoned with pepper	When eating at restaurants, I have seasoned my meal with pepper.	A hot-tasting spice is pepper	A salty-tasting spice is pepper
Pudding	I like eating pudding	When grocery shopping, I have often bought pudding	A creamy sweet desert defines pudding	A crunchy savory desert defines pudding
Toy	I have enjoyed playing with toys	When buying presents for children, I have often gotten a toy.	An object designed for playtime is a toy	An object designed for eating food is a toy
Strawberry	I enjoy fruit salad with strawberries	During the summer, I go to the market to get strawberries.	A sweet red fruit that grows on low plants is a strawberry	A tart red fruit that grows on tall trees is a strawberry
Candy	I prefer soft over hard candy	On Halloween, I have bought candy	A sweet food made of sugar or syrup defines a candy.	A bitter food made of flour or sauce defines a candy.
Salad	I enjoy eating salad	During the summer, I have made fresh salads	A healthy meal made of lettuce and vegetables is a salad.	An healthy meal of meat and potatoes is a salad.
Restaurant	I enjoy eating in restaurants	For special occasions, I have celebrated at a restaurant	An establishment where one pays to eat a meal is a restaurant.	An establishment where one pays to sleep the night is a restaurant.
Lemon	I enjoy the sour taste of a lemon	When drinking certain beverages, I have added a slice of lemon	A yellow oval acidic fruit is a lemon.	A small round blue fruit is a lemon.
Insect	I do not like insects	I have set up traps around my house for insects	A mosquito is a type of insect	A bird is a type of insect
Animal	I enjoy being around animals	When I have walked in the park, I have seen animals	Multicellular, air-breathing creatures are animals	Single-cell, water breathing creatures are animals

Stain	It bothers me when I see my clothes have stains	When I have worn a shirt, I have gotten a stain	Dirty marks that are difficult to remove are stains	Crumbs that are easy to brush away are stains.
Sea	I like the smell of bodies of water like the sea	For summer vacations, I have visited the sea	A large body of salt water is the sea	A large body of fresh water is the sea

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