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THE ROLE OF KNOWLEDGE ACCESSIBIILITY IN EPISODIC FUTURE THOUGHT

By

Karl K. Szpunar

A dissertation presented to the
Graduate School of Arts and Sciences
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Abstract

The capacity to think about specific events that one might encounter in the future—episodic future thought—involves the flexible (re)organization of knowledge. However, little is known about the cognitive mechanisms that guide this process. The reported studies demonstrate evidence for the role of knowledge accessibility as one such mechanism. First, comparisons were drawn between episodic future thought and other cognitive tasks that similarly require participants to produce open-ended responses and for which the role of knowledge accessibility is well established. Second, three experiments (N = 270) provided direct tests of whether accessible knowledge becomes incorporated into episodic future thought. In Experiments 1 and 2, priming knowledge relevant to an upcoming episode generation task shaped the content of thoughts about the future. Experiment 3 revealed that, as with other open-ended production tasks, primed knowledge must be processed in a meaningful manner in order for it to exert an influence on the content of episodic future thought. These results further understanding of episodic future thought and suggest important avenues for future research.

The capacity to think about specific events that one might encounter in the future—episodic future thought—is currently attracting a great deal of empirical attention in both psychology and neuroscience (Atance & O'Neill, 2001; Schacter, Addis, & Buckner, 2007, 2008; Szpunar, in press). Perhaps the most appealing aspect of this emerging literature is that very little is known about the cognitive mechanisms that underlie episodic future thought. Although a considerable amount of research has highlighted the functional benefits of thinking about personal future episodes (Boyer, 2008; Suddendorf & Corballis, 2007; Taylor, Pham, Rivkin, & Armor, 1998; Taylor & Schneider, 1989), not until recently have psychologists and neuroscientists begun to ask how episodic future thought is implemented by the human mind/brain.

As an example, consider the following scenario generated by a college student who had been asked to think about an upcoming life event (Table 1). In contemplating her forthcoming vacation, the participant generated a clear mental representation of the context in which the event will take place, the people involved, the objects that are salient in the environment, and relevant emotions. It is apparent that one must be able to flexibly rely upon one's existing knowledge base in order to construct such a specific scenario (Schacter & Addis, 2007; Szpunar, in press). Indeed, recent findings from neuroimaging (e.g., Addis, Wong, & Schacter, 2007; Botzung, Denkova, & Manning, 2008; Okuda et al., 2003; Szpunar, Watson, & McDermott, 2007), neuropsychology (e.g., Hassabis, Kumaran, Vann, & Maguire, 2007; Klein, Loftus, & Kihlstrom, 2002; Rosenbaum, Gilboa, Levin, Winocur, & Moscovitch, in press; see also Tulving, 1985), clinical

Table 1.

A personal future episode from a sample participant

Cue: Imagine a specific event that you anticipate happening in your future

“I am on the beach in Nice. It is July, and I have just completed my senior year of college. I am wearing a white skirt and a bright colored tank top, sitting on my old beach towel. My flip-flops are sitting next to me. I feel the warm sun on my feet. Next to me, Kelly is asleep, basking in the sun, with her huge summer hat over her face. Hiten and Neha are walking along the water. I think about how they should just get it over with and hold hands, but I know they won’t. For the most part, I am very content to just sit, feel the nice breeze, and watch the waves lap at the shore. It’s a relaxing moment, and I realize it is one of my last before graduate school. I ignore the nervousness building in my stomach, and I lay back and look at the few clouds in a bright blue sky.”

psychology (e.g., D'Argembeau, Raffard, & Van der Linden, 2008), and developmental psychology (e.g., Addis, Wong, & Schacter, 2008; Atance, 2008; Atance & O'Neill, 2005; Busby & Suddendorf, 2005) have shown that memory plays a fundamental role in the ability to envision personal future episodes.

For instance, research from the neuroimaging literature has revealed a striking similarity in the neural activity that characterizes episodic future thought and the capacity to call to mind specific experiences from one's personal past (i.e., episodic memory) (e.g., Addis et al., 2007; Szpunar et al., 2007). This finding has been taken as evidence that similar processes underlie the two abilities (Buckner & Carroll, 2007; Hassabis & Maguire, 2007; Schacter & Addis, 2007; Spreng, Mar, & Kim, in press). Of particular interest are posterior cortical regions (e.g., posterior cingulate cortex, parahippocampal cortex, hippocampus) that are known to play an important role in the retrieval of memories from one's past (Cabeza & St. Jacques, 2007; Maguire, 2001; Svoboda, McKinnon, & Levine, 2006). That episodic future thought engages these regions in a similar manner as remembering suggests that the contents of memory may in fact be accessed as participants think about their future. In a recent study, Szpunar, Chan & McDermott (in press) tested whether posterior cortical regions contribute memory-related contents to episodic future thought by manipulating the extent to which participants were able to draw upon previous experiences when thinking about the future. In two tasks, participants imagined personal future and past episodes occurring in the context of familiar settings (e.g., their apartment). In a third task, participants generated personal future episodes occurring in the context of unfamiliar settings (e.g., a jungle). Post-scan questionnaires ensured that participants had no specific memories associated with the unfamiliar settings. Regions within posteriomedial parietal cortex and the medial temporal lobes (previously identified by Szpunar et al., 2007) were similarly engaged as participants imagined themselves in familiar contexts. However, the same regions exhibited relatively little neural activity as participants generated personal future episodes in unfamiliar contexts. Hence, it appears that posterior cortical structures associated with episodic future thought (and remembering) become engaged to the extent that the construction of personal future episodes relies on the bringing to mind of previous experiences.

Importantly, the above-mentioned findings have been corroborated by research with neuropsychological patients. In particular, these studies have shown that damage to brain regions associated with episodic memory retrieval (e.g., medial temporal lobes) results in an accompanying deficit to the ability to imagine personal future episodes. For instance, Hassabis et al. (2007) studied five patients with brain damage limited to the hippocampus (a structure buried deep in the medial temporal lobes that is thought to be particularly important for episodic memory). Interestingly, these patients had retained their ability to know many things about their past (e.g., names of family and friends, along with other general knowledge) but were densely amnesic for previous experiences from their lives. Further, these patients were markedly impaired in their ability to imagine personal future episodes. In line with the findings presented in relation to the neuroimaging literature, the authors suggested that both remembering and episodic future thought rely on intact medial temporal lobe structures (particularly the hippocampus).

Finally, the finding that deficits of episodic future thought accompany deficits of episodic memory has been demonstrated in a variety of patient populations, including suicidally depressed individuals (Williams et al., 1996), patients with schizophrenia (e.g., D'Argembeau et al., 2008), children under the age of 5 years (e.g., Busby & Suddendorf, 2005), and older adults (Addis et al., 2008). Taken together, the evidence suggests a close relationship between the personal past and future. However, it does not specify the nature of the relation.

To date, little is known about the cognitive mechanisms that guide the process of (re)organizing information from one's knowledge base in the course of episodic future thought. In fact, much of this process likely occurs beyond conscious awareness (at least when one is not specifically asked to contemplate the process). For instance, there exists a large amount of knowledge that is relevant to any given cue to generate a personal future episode (either in daily life or in the laboratory). Further, the knowledge that is applicable to any such cue may *potentially* be used to generate a large number of alternative scenarios (e.g., exactly where the event will take place, who will be involved, what objects will be salient, and so on). How is it that one specific scenario comes to mind (cf. Table 1)?

The purpose of this dissertation is threefold. First, a cognitive mechanism is proposed that may reasonably be thought to guide the use of one's knowledge in episodic future thought. Namely, it is hypothesized that episodic future thought incorporates applicable knowledge that is in a relatively *accessible* state at the time a specific scenario is being generated.

Second, support for this *accessibility hypothesis* is gained by drawing comparisons between episodic future thought and various other cognitive tasks that similarly require participants to generate an open-ended response to a presented cue and for which the role of knowledge accessibility is well established. Although episodic future thought represents a new area of scientific inquiry, it does share links to existing lines of research, and it is likely that significant progress in understanding episodic future thought can be made by grounding the concept in our more developed understanding of human cognition. Notably, these related cognitive tasks represent three ostensibly *unrelated* areas of psychological research—conceptual implicit priming, impression formation, and sentence production—that have previously shared little crosstalk.

Finally, three experiments are described that provide direct tests of whether, and under what circumstances, accessible knowledge becomes incorporated into episodic future thought. Briefly, the rationale behind all three experiments is that if accessible knowledge is utilized in episodic future thought, then manipulations that influence the accessibility of knowledge (e.g., priming) should shape the content of participant-generated episodes. A better understanding of the role of knowledge accessibility in episodic future thought should provide insights into this ubiquitous mental phenomenon.

Accessibility Hypothesis

As was alluded to in the Introduction, the mental representation of a personal future episode will have many *potentially* relevant features (i.e., various settings, people, objects, emotions) and may result in any number of specific arrangements of those features (i.e., scenarios). The hypothesis of this dissertation states that currently *accessible* knowledge that is applicable to a given cue to generate a personal future episode should play an important role in determining the specific scenario that comes to mind.

Some clues for this hypothesis were garnered from an informal interview of the sample participant mentioned earlier (Table 1). The only initial constraint placed on the participant was to think about an upcoming life event. The participant claimed that her planned trip to Nice was the first event that came to mind (see Appendix A). One possibility is that this information was both applicable to the presented cue and in a relatively accessible state (e.g., possibly because of recent thought about similar events). Further, there were different scenarios that the participant could have imagined in relation to her planned trip. For instance, she could have imagined a vacation scenario that involved site seeing rather than lying on a beach. Again, the participant reported that she thought about the first setting that came to mind (i.e., she had recently thought about wanting to be on a beach; see Appendix A). Indeed, it seems that the participant was relying upon readily accessible knowledge to help her complete the task.

Of course, the descriptions and explanations provided by the participant and conjectures supplied by the experimenter afford little in the way of evidence with regard to the hypothesis that accessible information might influence the content of episodic future thought. However, this hypothesis is certainly testable. Importantly, support for this hypothesis may be gained from examining the role of knowledge accessibility in the extant psychological literature involving various other open-ended production tasks. Next, we will briefly review findings from conceptual implicit memory, impression formation, and sentence production. In each case, accessible (and applicable) knowledge appears to be given precedence as participants generate open-ended responses.

The Role of Knowledge Accessibility in Open-ended Production Tasks

Conceptual Implicit Memory

Over the past 25 years, psychologists have expressed interest in the non-conscious influence of memory on task performance. Much of this research has been conducted under the guise of *implicit memory*—revealed when previous experiences facilitate performance on a task that does not require conscious recollection of those experiences (Roediger & McDermott, 1993; Schacter, 1987). There are two phases in the typical implicit memory experiment. First, participants are exposed to a set of materials (e.g., a list of words, pictures, or sentences). Second, participants complete an ostensibly unrelated task that is actually designed to assess the extent to which information learned during the first task (e.g., the word 'cheetah') facilitates performance during the second task (e.g., complete the word fragment c h_ _ t _ _ with the first word that comes to mind;

answer the question 'What is the fastest animal on the planet?'). The enhanced performance on the second task for items related to previously studied information relative to items unrelated to previously studied information is referred to as priming. Information learned during the first phase may facilitate performance during the second phase if: 1) stimuli in the two tasks share perceptual features in common (e.g., completing the word fragment c h _ _ t _ _ as 'cheetah'), 2) stimuli in the two tasks are conceptually related (e.g., answer 'cheetah' to the question 'What is the fastest animal on the planet?') or 3) some combination of perceptually- and conceptually-driven processes (for a detailed review see Roediger, Weldon, & Challis, 1989).

Of particular interest to the topic of this dissertation are conceptual implicit memory tasks. In the typical conceptual implicit task, participants are required to produce an open-ended response that is meaningfully related to a presented cue (e.g., produce an answer to a general knowledge question, generate a list of exemplars relevant to a category cue, or generate the first word that comes to mind in response to a cue word). As is the case with most studies of implicit memory, the question of interest is whether participants who were previously exposed to a critical piece of information are more likely to incorporate that information into their response at the time of the test. Indeed, this appears to be the case. For instance, participants are more likely to correctly answer general knowledge questions if they were exposed to the answer in an unrelated learning phase (e.g., Blaxton, 1989; Challis & Sidhu, 1993). Similarly, participants are more likely to incorporate a critical exemplar (typically of low frequency; e.g., cheetah) during a category instance generation task (e.g., list the first 8 animals that come to mind, McDermott & Roediger, 1996; see also Mulligan, 1997; Rappold & Hashtroudi, 1991; Srinivas & Roediger, 1990) if they have been previously exposed to that item.

Importantly, the extent of priming that one observes on conceptual implicit tasks appears to be sensitive to how meaningfully the critical information was initially processed. For instance, Blaxton (1989, Experiment 1) had participants study a list of words under one of three orienting conditions. Some of these critical words were presented next to an associated word (e.g., jaguar—cheetah) and participants were asked to read the associate silently ("jaguar") and then the critical word aloud ("cheetah"). Other critical words were presented with no context (e.g., XXX—cheetah) and, again, participants were asked to read the critical word aloud. In a third condition, participants were presented with the first letter of the critical word next to an associated word (e.g., jaguar—c___) and were asked to generate the critical word from the cue (see also Jacoby, 1983).

Among the various tests subsequently administered by Blaxton was a conceptual implicit memory task that required a subset of participants to answer general knowledge questions (e.g., 'What is the fastest animal on earth?'). Regardless of orienting task, prior exposure to the critical words enhanced the probability that participants came up with a correct answer to general knowledge questions (Figure 1). However, as can be seen in Figure 1, participants were most likely to correctly answer general knowledge questions related to the critical words they had generated, followed by questions related to words they had read in context,

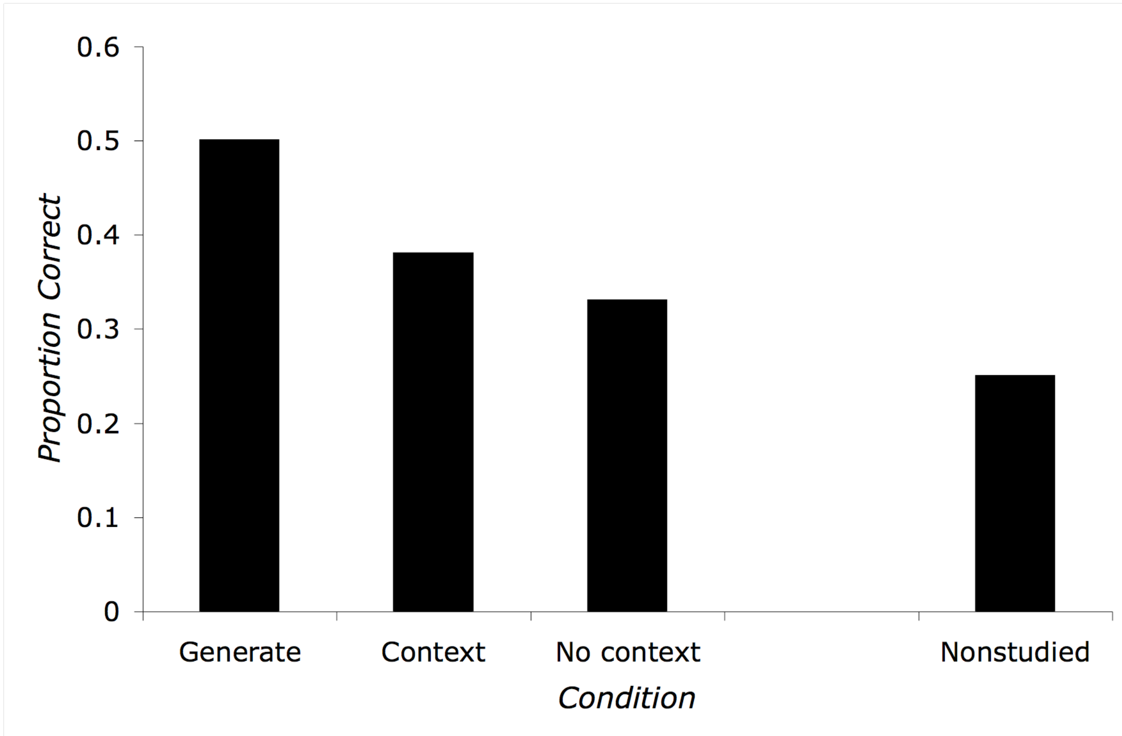

Figure 1. Proportion general knowledge questions correct as a function of exposure condition (data adapted from Blaxton, 1989).

and finally questions related to words they had read with no context. This finding was attributed to the idea that generating a critical word in relation to an associate necessarily engages conceptual processes, while reading a critical word without context probably does so to a lesser extent (and likely less so than reading a critical word in context). However, since the no-context condition did show some priming, it is likely that some meaning-based processing was engaged by simply reading the critical words. Indeed, Srinivas and Roediger (1990, Experiment 1) showed that disrupting conceptual processing (i.e., by inducing structural processing of the stimulus in the exposure phase) eliminated priming on a conceptual implicit task (they also used general knowledge questions). This point will be rehashed in discussing the rationale behind Experiment 3 of this dissertation.

Taken another way, the research on conceptual implicit memory discussed above suggests that accessible (and applicable) information plays an important role when participants are required to produce an open-ended response that is meaningfully related to a cue. That is, information in the participant's knowledge base that is applicable to the task at hand and also in a relatively accessible state (as a result of prior exposure; especially if that exposure involved processing the critical item in a meaningful way) will influence the semantic content of the participant's response (see also Blaxton, 1989, Experiment 3; Brown & Mitchell, 1994; Hamann, 1990; Mulligan, 1997). Next, we turn to an ostensibly unrelated line of research in the social psychological literature that has examined the role of category accessibility on impression formation. As will be seen, the methods employed by researchers studying impression formation bear a close resemblance to those employed in the implicit memory literature. Indeed, the general pattern of empirical regularities that has emerged from studies of conceptual implicit memory appears to hold in relevant studies of impression formation.

Impression Formation

A considerable amount of research in the social psychological literature has been directed towards delineating the role of category accessibility on person perception (e.g., DeCoster & Claypool, 2004; Forster & Liberman, 2007; Higgins, 1996; Srull & Wyer, 1979, 1980). The basic underlying assumption of this line of research is that people use broad conceptual categories to encode information about behavior into memory (Bartlett, 1932; Bruner, 1957). In many instances, however, behaviors that one observes are ambiguous and may be interpreted in more than one way. For instance, Srull and Wyer (1979) give the example of someone telling his girlfriend that her new hairstyle is unattractive. This behavior could potentially be interpreted as either ‘honest’ or ‘unkind’. Srull and Wyer (see also Higgins, Rholes, & Jones, 1977) suggest that the manner in which ambiguous behaviors, such as the one described above, are interpreted depends on the concepts that are currently accessible in one’s knowledge base (cf. Tversky & Kahneman, 1973).

In their seminal study, Higgins et al. (1977) provided direct evidence for the role of knowledge accessibility in impression formation. The study involved two ostensibly unrelated phases. In the first phase, different groups of participants were exposed to various trait terms. In the second phase (presented as a separate experiment), participants read a vignette about an unfamiliar individual (Donald) who performed a series of ambiguous behaviors that could either be regarded as ‘adventurous’ or ‘reckless’ (e.g., Donald thought about crossing the Atlantic in a sailboat). The manipulation of interest was whether, in the first phase of the experiment, participants had been exposed to trait terms related to adventurousness or recklessness. If accessible category knowledge (i.e., as a result of recent exposure) is used to interpret ambiguous behavior, then participants should produce descriptions of Donald that are congruent with the previously presented trait terms. As can be seen in Figure 2, participants who had been exposed to adventure-related terms were more likely to describe the ambiguous behavior positively (e.g., adventurous, brave, courageous) whereas participants who had been exposed to reckless-related terms were more likely to describe Donald’s behavior negatively (e.g., reckless, self-centered, stubborn).

Several important points about the Higgins et al. (1977) experiment deserve mention. First, the structure of the experiment (i.e., two unrelated phases) represents the modal experimental design that is used to study impression formation. Although the nature of the exposure phase (e.g., presenting individual words, presenting sentences, and so on) and the nature of the description provided by participants in the second phase (e.g., an open-ended description, rating a specific trait on a Likert scale) may vary, the general design is clearly similar to those discussed in relation to conceptual implicit

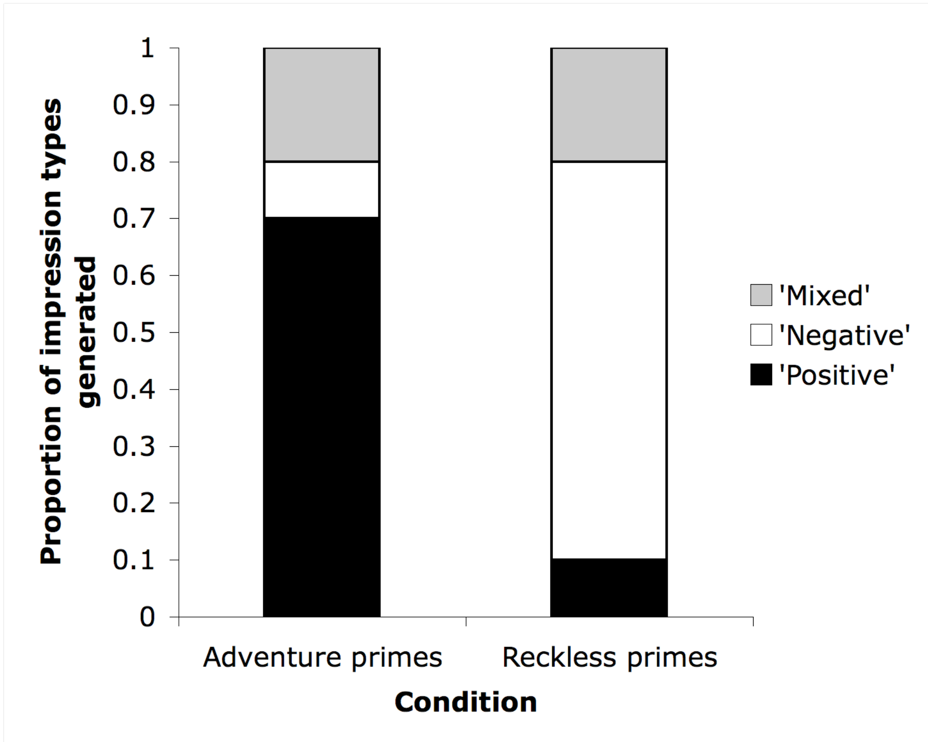

Figure 2. Proportion of impression types generated as a function of exposure condition (data adapted from Higgins et al., 1977).

memory tasks. Importantly, the Higgins et al. experiment required participants to generate a response (i.e., describe Donald's behavior) rather than rate the ambiguous behavior along a relevant dimension (e.g., how adventurous was Donald?). In that sense, this experiment (along with others, e.g., Higgins, Bargh, & Lombardi, 1985) can be considered an examination of the role of knowledge accessibility on the production of an open-ended response (as was the case with conceptual implicit memory tasks).

Finally, the level of priming obtained on impression formation tasks has also been shown to depend on the extent to which the primed information is processed in a meaningful way. Smith and Branscombe (1988) showed that participants who had generated trait terms from conceptual cues were more likely to show priming in their description of an ambiguous behavior than participants who had simply read the trait terms. As discussed above, this is a consistent feature of conceptual implicit memory tasks (see Roediger, Weldon, & Challis, 1989). Next, we will consider some converging evidence for the role of accessible information in an open-ended sentence production task.

Sentence Production

The role of accessible (and applicable) information has also received some attention in studies of sentence production. Bock and her colleagues (e.g., Bock, 1982; Bock & Irwin, 1980) have shown that the syntactical structure of participant-generated sentences may be influenced by lexical information that is in a temporarily accessible state (i.e., as a result of recent exposure). Although many of these studies have focused on the reproduction of sentences from memory (e.g., Bock & Irwin, 1980; Perfetti & Goldman, 1975), others have examined tasks in which production is more open-ended. For instance, participants in one study (Bock, 1986) were asked to describe a series of pictures depicting events involving an agent and a patient (e.g., a bee stinging a man). Although each picture could potentially be described in a number of alternative ways, Bock was particularly interested in two descriptions that participants typically came up with: 1) an active sentence (e.g., "the bee is stinging the man"), in which the agent is mentioned first and 2) its corresponding passive (e.g., "the man is being stung by a bee"), in which the patient is mentioned first. Importantly, participants were unconstrained in how they chose to describe the pictures. The manipulation of interest, for our purposes, was whether participants were primed (immediately before seeing the picture) with an auditory presentation of a word that was semantically related to either the agent (e.g., honey) or the patient (e.g., adult) depicted in the event.

As can be seen in Figure 3, significantly more sentences were generated with the primed target (i.e., agent or patient) mentioned first. Interestingly, phonological primes related to the agent (e.g., fee) or patient (e.g., can) had no effect on the syntactical structure of participant generated sentences. Participants were required to process each picture in a meaningful way in order to produce accurate descriptions of the depicted events. Hence, only the accessibility of information related to the meanings of words (which was applicable to the nature of their task) affected the syntax of the generated sentences (see also Garrett, 1975, 1980). Taken another way, these results

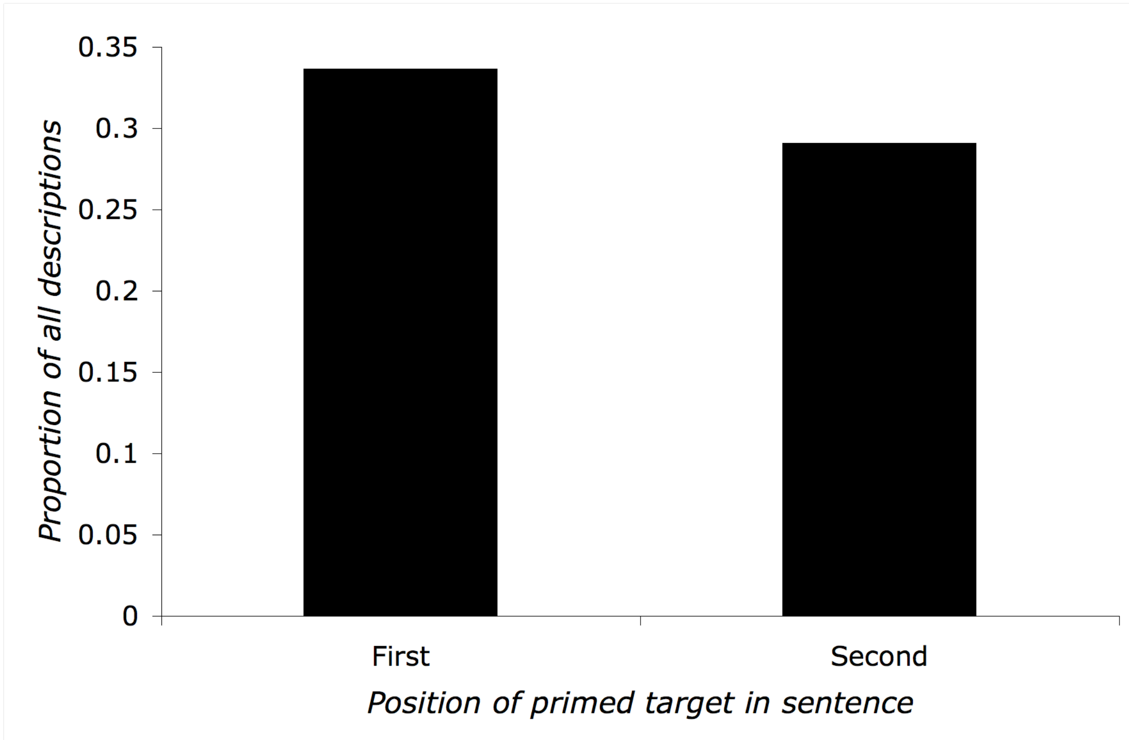

Figure 3. Proportion of participant generated sentences in which primed target words (i.e., agent or patient) were mentioned first or second (data adapted from Bock, 1986).

represent further evidence that temporarily accessible (and applicable) information may influence the product of an open-ended response, in this case the syntactical structure of a sentence.

Relevance to Episodic Future Thought

One may reasonably infer, based on the above review of three ostensibly unrelated lines of research, that accessible (and applicable) knowledge has a strong influence on open-ended production tasks. As such, confidence is gained in the hypothesis that a similar pattern of results might emerge in the context of episodic future thought. To the extent that episodic future thought is open-ended (i.e., based on initial constraints; e.g., task instructions), relevant information that is in a relatively accessible state should determine the content of a participant-generated episode. Such an outcome would provide insight into this little understood, but ubiquitous, mental phenomenon. This hypothesis was the focus of Experiments 1 and 2 of this dissertation.

Further, because parallels have been drawn between episodic future thought and other open-ended production tasks, it will be important to demonstrate that certain variables known to influence open-ended production in general have a similar influence on episodic future thought. As was discussed above, the extent to which primed knowledge biases performance on conceptual implicit tasks, impression formation tasks, and sentence production tasks depends on how meaningfully that information is initially processed. Experiment 3 will examine whether a similar pattern of results emerges in the context of episodic future thought.

Introduction to the Experiments

Three experiments were conducted to begin to answer the question of interest: What is the role of knowledge accessibility in episodic future thought? In order to gain some leverage on this issue, a priming paradigm was implemented that bears a family resemblance to those discussed earlier in relation to implicit memory, impression formation, and sentence production. That is, the paradigm was designed to examine whether participant-generated episodes of the future would be influenced by relevant information that they had been exposed to on an earlier, ostensibly unrelated, exposure task.

Specifically, in each of the experiments that will be discussed below, participants were instructed to complete a series of three mental manipulation tasks: 1) constructing sentences from scrambled arrangements of words, 2) solving math problems, and 3) generating a personal future episode. The cover story was that the experimenter was interested in whether participants who are good at mentally manipulating one type of information (i.e., verbal or non-verbal) are also good at mentally manipulating other types of information. In reality, the sentence construction task (which was always completed first in the context of a between-subjects design) did or did not prime participants with knowledge relevant to the third, and final, episode generation task. The question of interest, in all three experiments, was whether (and under what circumstances) knowledge that was made accessible through priming would shape the content of participant-generated episodes. The mental math task simply served as a brief delay between the exposure phase and episode generation phase, and to enhance the credibility of the cover story.

Experiment 1: Knowledge Accessibility in Episodic Future Thought

The purpose of Experiment 1 was to examine whether, given a predetermined set of constraints, the content of episodic future thought would be influenced by applicable knowledge that was in a relatively accessible state. Specifically, participants in this experiment were asked to generate a personally relevant future event that might occur on or near their school campus within the next week. The constraints of this episode generation task were that the event must occur in a specific setting (on or near school campus) and within a specific time frame (next week). As such, the instructions delimited the information that could potentially become incorporated into the episode. Nonetheless, there remain a large number of scenarios that participants could potentially imagine in relation to this cue. The question of interest was whether participants would be more likely to generate social (e.g., going to a party) or academic (e.g., going to class) scenarios after they had been primed to think about information relevant to similar situations (i.e., social or academic) in the context of an earlier task.

Before this experiment is outlined in more detail, one issue deserves mention. Although students are likely to think about events that occur on or near their school campus in their daily lives, it is unlikely that they are ever asked to think about the first such event that comes to mind. Rather, episodic future thought typically reflects events that one is currently excited or anxious about (which, for a student, may often times involve a campus related setting).

However, in order to make the study of knowledge accessibility in episodic future thought tractable, it is necessary to introduce experimentally defined constraints on episodic future thought. That way, the experimenter can have an idea of what types of situations are applicable to a given cue and examine whether making knowledge related to a specific situation more accessible will shape the content of participant-generated episodes.

Design

There was one between-subjects variable, with 3 levels (priming condition: *social* group, *academic* group, *control* group), in this experiment. Notably, a between-subjects design was instantiated (in all 3 experiments) based on well-documented evidence from the social psychological literature that significant effects of priming are difficult to obtain when multiple concepts are primed in a single experimental session (e.g., DeCoster & Claypool, 2004).

Method

Participants

Thirty undergraduates were recruited for each level of the between subjects variable, yielding a total of 90 participants for this experiment. Two-thirds of the participants in each condition were tested at Washington University in St. Louis and one-third were tested at Iowa State University.

Materials

A separate set of materials was administered in each of the three phases of the experiment (i.e., sentence construction, math, episode generation). During the sentence construction phase (phase 1), participants generated meaningful sentences in response to scrambled arrangements of words (c.f. Costin, 1969; Srull & Wyer, 1979, 1980). A total of 30 scrambled word cues were used in this experiment (see Appendix B for a complete list of stimuli). Six of these scrambled word cues specified social situations, 6 were related to academic situations, and 18 were control cues that did not converge on a specific situation. During the delay period (phase 2), participants were asked to solve 6 multiplication problems [e.g., (6 x 13)/2 = ?]. Finally, in the episode generation phase (phase 3), participants were asked to construct a personally relevant future event that might occur on or near their school campus within the next week (see Appendix C for complete set of instructions).

Procedure

Participants were initially informed that this experiment was designed to test their ability to mentally manipulate verbal (sentence construction) and non-verbal (math and episode generation) stimuli. Further, it was explained to them that the experimenter was interested in whether people who are good at mentally manipulating one type of stimuli are also good at mentally manipulating other types of stimuli. Accordingly, participants were asked to complete each one of the three tasks as quickly and as accurately as possible. Finally, participants were told that the three tasks would be presented in random order. In fact, the order of task presentation was consistent across participants (i.e., sentence construction, math, episode generation).

In the first phase of the experiment, each participant was presented with 18 (of 30) scrambled word cues. The scrambled word cues appeared one at a time in the center of a computer screen and each contained 5 words that were arranged in a nonsensical order (e.g., fun the was party boring). Participants were required to use 4 of the words in each cue to generate a sentence that was most relevant to them (e.g., the party was fun) and to type in their responses as quickly as possible. Responses were typed in a space provided directly below each cue.

Participants in the *social* group were presented with 6 scrambled word cues that could be used to generate sentences related to social situations and 12 cues that did not converge on a specific situation. The order of presentation of the scrambled word cues was such that the 6 social cues appeared in positions three, six, nine, twelve, fifteen, and eighteen. The remaining 12 positions drew a random selection of 12 of the 18 control cues. Participants in the *academic* group completed the experimental task in the same fashion, with the following exception. These participants were presented with 6 scrambled word cues that could be used to generate sentences related to academic situations, rather than social situations (but also appearing in positions three, six, nine, twelve, fifteen, and eighteen). Finally, participants in the *control* group were presented with (in random order) all 18 scrambled word cues that did not converge on a specific situation.

In the second phase, all participants were presented with 6 math problems. These math problems appeared one at a time in the center of a computer screen. Participants were required to answer these problems as quickly as possible. Responses were typed in a space provided directly below each question.

In the third phase, all participants were asked to construct a personally relevant future event that might occur on or near their school campus within the next week. Participants were instructed that they had two minutes to describe the event in as much detail as possible. Responses were typed in a space provided directly below the cue.

Finally, upon completing the experiment, all participants were asked two questions that served as a manipulation check. First, participants were asked to guess the true purpose of the experiment. Second, participants were asked to indicate when they initially became aware of this purpose. The data of any participant who claimed that information from the sentence construction phase influenced the nature of their episodic future thought, and who was aware of this influence during the course of the experiment, was excluded from analysis. The entire experiment took approximately 30 minutes to complete.

Results and Discussion

Scoring Criteria

All 90 participant-generated episodes were classified as either depicting a social, academic, or unrelated scenario by two independent raters who were blind to experimental conditions. Raters were instructed to score a scenario as ‘social’ if the depicted event focused on the participant’s social interactions with others (e.g., attending a party, eating lunch with a group of friends at school), as ‘academic’ if the event focused on the participant’s academic obligations (e.g., attending class, studying for a test), and as ‘unrelated’ if the event did not constitute a social or academic activity (e.g., walking around campus, waking up in the morning).

The resulting inter-rater reliability was high, K = .91 (Cohen, 1960). Any disagreements between raters were discussed and assigned to a single category. This was only the case for 5 events. Exclusion of these events did not change the general pattern of results and so these events were included in all subsequent analyses.

Manipulation Check

All 90 participants were unaware of the true purpose of the experiment at the time they generated their episodic future thought. In fact, once prompted to guess the true purpose of the experiment, only one participant was able to do so. This participant was in the *academic* group. Interestingly, they did not generate an episode that was congruent with the primes they had been exposed to earlier (i.e., academically relevant sentences). Since this individual claimed that they were not aware of the purpose until they had been instructed to think about it, their data was included in all subsequent analyses (cf. Schacter, Bowers, & Booker, 1989).

Distribution of Events

The distribution of future episodes generated by participants in the *social*, *academic*, and, *control* groups is presented in Figure 4. In order to examine whether recent exposure to relevant information (i.e., situations depicted in

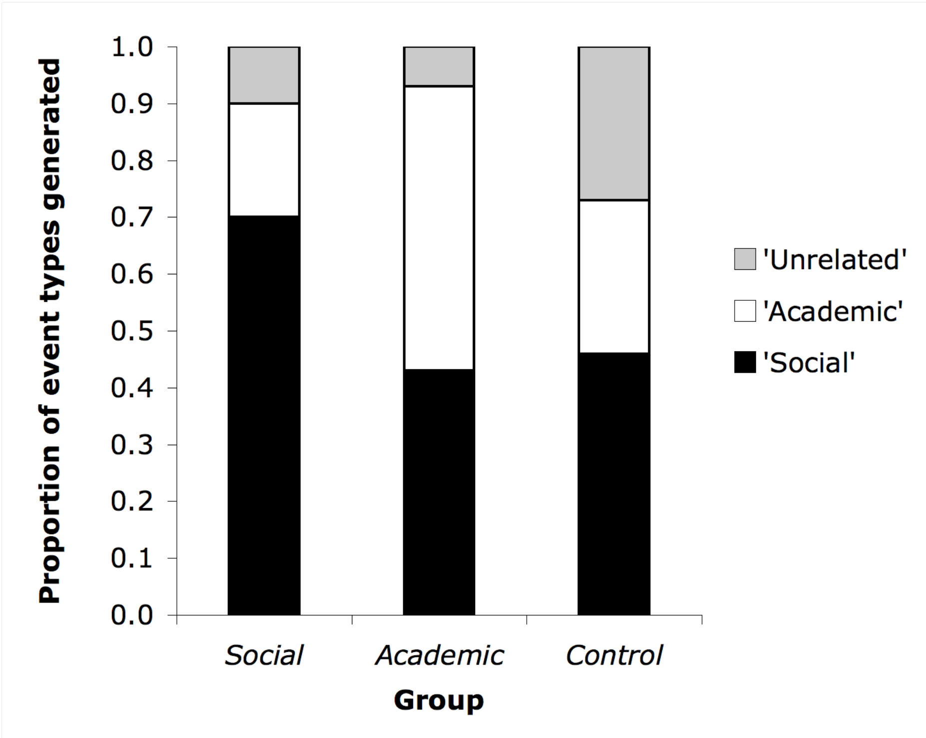

Figure 4. Results for Experiment 1. Proportion of event types generated as a function of priming condition. Relative to the *control* group, participants in the *social* group generated more socially relevant future thoughts. Similarly, participants in the *academic* group generated more academically relevant future thoughts than those in the *control* group.

sentences) shaped the content of participant generated episodes, the distribution of events generated by participants in the *social* and *academic* groups were separately contrasted against the distribution of events generated by participants in the *control* group.

First, a chi-square goodness-of-fit test indicated that the distribution of events generated by participants in the *social* group (i.e., 21 'social' scenarios, 6 'academic' scenarios, and 3 'unrelated' scenarios) differed significantly from the distribution of events generated by participants in the *control* group (i.e., 14 'social' scenarios, 8 'academic' scenarios, and 8 'unrelated' scenarios), χ^2 (2, N= 30) = 7.13, p = .028. This analysis was followed with three a-priori contrasts that separately examined the difference in proportions of 'social', 'academic', and 'unrelated' events generated by the *social* and *control* groups. Two comparisons reached significance. Critically, participants in the *social* group were more likely to generate a socially relevant scenario than those in the *control* group (Z = 1.87, p = .031). Further, participants in the *control* group were more likely to generate an unrelated scenario than those in the *social* group (Z = 1.77, p = .038).

A second chi-square goodness-of-fit test indicated that the distribution of events generated by participants in the *academic* group (i.e., 13 'social' scenarios, 15 'academic' scenarios, and 2 'unrelated' scenarios) also differed significantly from the distribution of events generated by the *control* group (i.e., 14 'social' scenarios, 8 'academic' scenarios, and 8 'unrelated' scenarios), χ^2 (2, N= 30) = 10.69, p =.005. This analysis was also followed with three a-priori contrasts that separately examined the difference in proportions of 'social', ‘academic’, and ‘unrelated’ events generated by the *academic* and *control* groups. Two comparisons reached significance. Critically, participants in the *academic* group were more likely to generate an academically relevant scenario than those in the *control* group ($Z = 2.47$, $p = .007$). Further, participants in the *control* group were more likely to generate an unrelated scenario than those in the *academic* group ($Z = 2.12$, $p = .017$).

Discussion

These results present clear evidence that knowledge accessibility influences the content of episodic future thought. Participants in the *social* and *academic* groups were more likely than would be expected by chance to generate future episodes that were congruent with the relevant information that they had recently been exposed to in the context of a sentence construction task (i.e., social and academic situations, respectively).

Experiment 2: Knowledge Accessibility with Higher Levels of Constraint

The purpose of Experiment 2 was to extend the generality of the findings from Experiment 1 (that knowledge accessibility influences the content of episodic future thought). In Experiment 1, episodic future thought was constrained to a specific setting (on or near school campus) and time frame (next week). In Experiment 2, an additional constraint was introduced into the instructions specifying the nature of the episode generation task. Specifically, participants in this experiment were asked to construct a personally relevant future event that might occur on or near their school campus within the next week and that was related to an academic situation. That is, the episode was constrained to a specific setting (on or near school campus), a specific time frame (next week), and a specific activity (academic). While this additional constraint should further delimit the amount of knowledge that is applicable to the episode, there still exist a large number of alternative scenarios that one could potentially generate in response to this cue. The question of interest was whether participants would be more likely to generate an academically related scenario occurring in the context of a classroom (e.g., attending a lecture) or outside the classroom (e.g., studying in the library) after they had been primed to think about information relevant to similar situations (i.e., academic situations occurring inside or outside the classroom) in the context of an earlier task.

Design

There was one between-subjects variable, with 3 levels (priming condition: *classroom* group, *study* group, *control* group), in this experiment.

Method

Participants

Thirty undergraduates were recruited for each level of the between subjects variable, yielding a total of 90 participants for this experiment. Two-thirds of the participants in each condition were tested at Washington University in St. Louis and one-third were tested at Iowa State University.

Materials

A separate set of materials was administered in each of the three phases of the experiment (i.e., sentence construction, math, simulation). During the sentence construction phase (phase 1), participants generated meaningful sentences in response to scrambled arrangements of words. A total of 30 scrambled word cues were used in this experiment (see Appendix B for a complete list of stimuli). Six of these scrambled word cues specified classroom situations, 6 were related to studying outside the classroom, and 18 were control cues that did not converge on a specific situation (same control cues as Experiment 1). During the delay period (phase 2), participants were asked to solve 6 math problems [e.g., (6 x 13)/2 = ?] (same problems as Experiment 1). Finally, in the episode generation phase (phase 3), participants were asked to construct a personally relevant future event that might occur on or near their school campus within the next week and that was related to an academic situation (see Appendix C for complete set of instructions).

Procedure

The procedure for Experiment 2 was identical to that of Experiment 1, with the following exceptions. Participants in the *classroom* group were presented with 6 scrambled word cues that could be used to generate sentences related to academic situations occurring in the classroom and participants in the *study* group were presented with 6 scrambled word cues that could be used to generate sentences related to academic situations occurring outside the classroom (participants in both groups were also presented with 12 scrambled word cues that did not converge on a specific situation). As was the case in Experiment 1, participants in the *control* group were presented with (in random order) all 18 scrambled word cues that did not converge on a specific situation. After the intervening delay phase (i.e., math problems), participants in all three groups were asked to construct a personally relevant future event that might occur on or near their school campus within the next week and that was related to an academic situation. The entire experiment, including the manipulation check, took approximately 30 minutes to complete.

Results and Discussion

Scoring Criteria

All 90 participant-generated episodes were classified as either depicting an academic activity occurring inside the classroom, an academic activity occurring outside the classroom, or an unrelated scenario by two independent raters who were blind to experimental conditions. Raters were instructed to score a scenario as ‘classroom’ if the depicted event took place in the context of an academic class (e.g., listening to a lecture, taking a test), as ‘study’ if the event involved preparation for an upcoming academic obligation (e.g., studying in the library or at home), and as ‘unrelated’ if the event did not constitute an academic activity occurring inside or outside the classroom (e.g., walking between classes, purchasing materials for class).

The resulting inter-rater reliability was high, $K = .95$. Any disagreements between raters were discussed and assigned to a single category. This was only the case for 3 events. Exclusion of these events did not change the general pattern of results and so these events were included in all subsequent analyses.

Manipulation Check

All 90 participants were unaware of the true purpose of the experiment at the time they generated their episodic future thought. In fact, once prompted to guess the true purpose of the experiment, only one participant was able to do so. This participant was in the *classroom* group. As was the case in Experiment 1, this participant did not generate an episode that was congruent with the primes they had been exposed to earlier (i.e., sentences related to academic situations occurring in the classroom). Since this individual claimed that they were not aware of the purpose until they had been instructed to think about it, their data were included in all subsequent analyses.

Distribution of Events

The distribution of future episodes generated by participants in the *classroom*, *study*, and *control* groups is presented in Figure 5. In order to examine whether recent exposure to relevant information (i.e., situations depicted in sentences) shaped the content of participant generated episodes, the distribution of events generated by participants in the *classroom* and *study* groups were separately contrasted against the distribution of events generated by participants in the *control* group.

First, a chi-square goodness-of-fit test indicated that the distribution of events generated by participants in the *classroom* group (i.e., 10 ‘classroom’ scenarios, 9 ‘study’ scenarios, and 11 ‘unrelated’ scenarios) differed significantly from the distribution of events generated by participants in the *control* group (i.e., 5 ‘classroom’ scenarios, 11 ‘study’ scenarios, and 14 ‘unrelated’ scenarios), χ^2 (2, N= 30) = 6.01, p = .049. This analysis was followed with three a-priori contrasts that separately examined the difference in proportions of ‘classroom’,

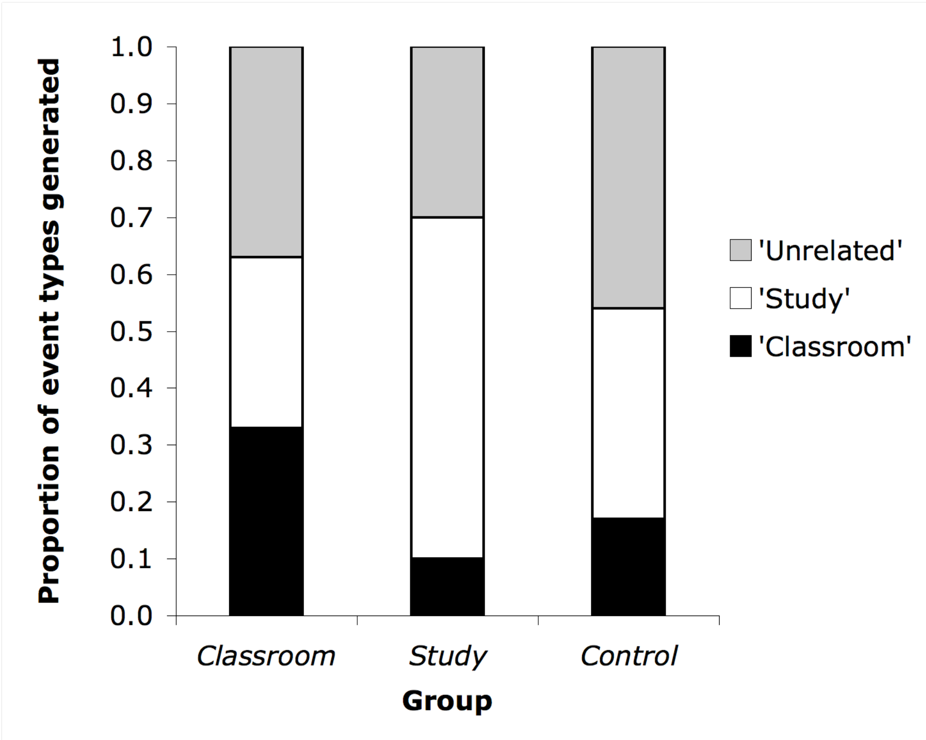

Figure 5. Results for Experiment 2. Proportion of event types generated as a function of priming condition. Relative to the *control* group, participants in the *classroom* group generated more academically relevant future thoughts occurring in the classroom. Similarly, participants in the *study* group generated more academically relevant future thoughts occurring outside the classroom than those in the *control* group.

‘study’, and ‘unrelated’ events generated by the *classroom* and *control* groups. Critically, one comparison reached significance, such that participants in the *classroom* group were more likely to generate an academically relevant scenario occurring in the classroom than those in the *control* group (Z = 2.23, p = .013).

A second chi-square goodness-of-fit test indicated that the distribution of events generated by participants in the *study* group (i.e., 3 ‘classroom’ scenarios, 18 ‘study’ scenarios, and 9 ‘unrelated’ scenarios) also differed significantly from the distribution of events generated by the *control* group (i.e., 5 ‘classroom’ scenarios, 11 ‘study’ scenarios, and 14 ‘unrelated’ scenarios), χ^2 (2, N= 30) = 7.04, p = .029. This analysis was also followed with three a-priori contrasts that separately examined the difference in proportions of ‘classroom’, ‘study’, and ‘unrelated’ events generated by the *study* and *control* groups. Critically, one comparison reached significance, such that participants in the *study* group were more likely to generate an academically relevant scenario occurring outside the classroom than those in the *control* group (Z = 2.11, p = .017).

Discussion

The results of this experiment are important in two respects. First, Experiment 2 serves as a conceptual replication of the findings obtained in Experiment 1. Second, these results provide further evidence for the role of knowledge accessibility in episodic future thought. Participants in the *classroom* and *study* groups were more likely than would be expected by chance to generate future episodes that were congruent with the relevant information that they had recently been exposed to in the context of a sentence construction task (i.e., academic situations occurring within and outside the classroom, respectively).

Experiment 3: Relating Episodic Future Thought to Other Open-ended Production Tasks

As was discussed earlier, the extent to which primed knowledge biases performance on open-ended production tasks (see Section 3) depends on how meaningfully that information is initially processed. In order to examine whether a similar relationship exists in the context of episodic future thought, participants in Experiment 3 were asked to process scrambled word cues in either a conceptual manner (i.e., similar to Experiments 1 and 2) or in a structural manner. If conceptually based processes moderate the relationship between primed knowledge and episodic future thought, then participants who process the scrambled word cues in a meaningful way should show more priming on a later episode generation task (for which the content of those cues is relevant; cf. Experiments 1 and 2) than participants who process those same cues in a non-meaningful manner (i.e., counting vowels).

Design

There was one between-subjects variable, with 3 levels (priming condition: *conceptual* group, *structural* group, *control* group), in this experiment.

Method

Participants

Thirty undergraduates were recruited for each level of the between subjects variable, yielding a total of 90 participants for this experiment. Two-thirds of the participants in each condition were tested at Washington University in St. Louis and one-third were tested at Iowa State University.

Materials

A separate set of materials was administered in each of the three phases of the experiment (i.e., sentence construction, math, simulation). During the sentence construction phase (phase 1), participants generated meaningful sentences (or counted vowels) in response to scrambled arrangements of words. A total of 24 scrambled word cues were used in this experiment (see Appendix B for a complete list of stimuli). Six of these scrambled word cues specified academic situations (same as Experiment 1) and 18 were control cues that did not converge on a specific situation (same control cues as Experiment 1). During the delay period (phase 2), participants were asked to solve 6 math problems [e.g., (6 x 13)/2 = ?] (same problems as Experiment 1). Finally, in the episode generation phase (phase 3), participants were asked to construct a personally relevant future event that might occur on or near their school campus within the next week (same as Experiment 1; see Appendix C).

Procedure

The procedure for Experiment 3 was identical to that of Experiment 1, with the following exceptions. Participants in the *conceptual* and *structural* groups were both presented with 6 scrambled word cues that could be used to generate sentences related to academic situations and 12 cues that did not converge on a specific situation. As was the case in Experiment 1, participants in the *conceptual* group were asked to use these cues to construct meaningful sentences. Participants in the *structural* group, however, were asked to count the number of vowels that were present in each cue (i.e., scrambled arrangement of words) as quickly and as accurately as possible. Responses for both groups were typed in a space provided directly below each cue. Finally, participants in the *control* group were asked to generate meaningful sentences in response to the 18 scrambled word cues that did not converge on a specific situation.

Results and Discussion

Scoring Criteria

All 90 participant-generated episodes were classified as either depicting an academic or unrelated scenario by two independent raters who were blind to experimental conditions. Raters were instructed to score a scenario as 'academic' if the event focused on the participant's academic obligations (e.g., attending class, studying for a test), and as 'unrelated' if the event did not constitute an academic activity (e.g., walking around campus, going to a party).

The resulting inter-rater reliability was high, $K = .90$. Any disagreements between raters were discussed and assigned to a single category. This was only the case for 4 events. Exclusion of these events did not change the general pattern of results and so these events were included in all subsequent analyses.

Manipulation Check

All 90 participants were unaware of the true purpose of the experiment at the time they generated their episodic future thought. In fact, once prompted to guess the true purpose of the experiment, no participant was able to do so.

Distribution of Events

The distribution of future episodes generated by participants in the *conceptual*, *structural*, and *control* groups is presented in Figure 6. In order to examine whether the manner in which primed knowledge was processed moderated the influence of that information on the content of participant generated episodes, the distribution of events generated by participants in the *conceptual* and *structural* groups were separately contrasted against the distribution of events generated by participants in the *control* group.

First, a chi-square goodness-of-fit test indicated that the distribution of events generated by participants in the *conceptual* group (i.e., 16 ‘academic’ scenarios and 14 ‘unrelated’ scenarios) differed significantly from the distribution of events generated by participants in the *control* group (i.e., 6 ‘academic’ scenarios and 24 ‘unrelated’ scenarios), χ^2 (2, N= 30) = 20.83, $p < .001$. This analysis was followed with two a-priori contrasts that separately examined the difference in proportions of ‘academic’ and ‘unrelated’ events generated by the *conceptual* and *control* groups. Both comparisons reached significance. Critically, participants in the *conceptual* group were more likely to generate an academically relevant scenario than those in the *control* group ($Z = 4.08$, $p < .001$). Further, participants in the *control* group were more likely to generate an unrelated scenario than those in the *conceptual* group ($Z = 2.04$, $p = .021$).

A second chi-square goodness-of-fit test indicated that the distribution of events generated by participants in the *structural* group (i.e., 8 ‘academic’ scenarios and 22 ‘unrelated’ scenarios) did not differ from the distribution of

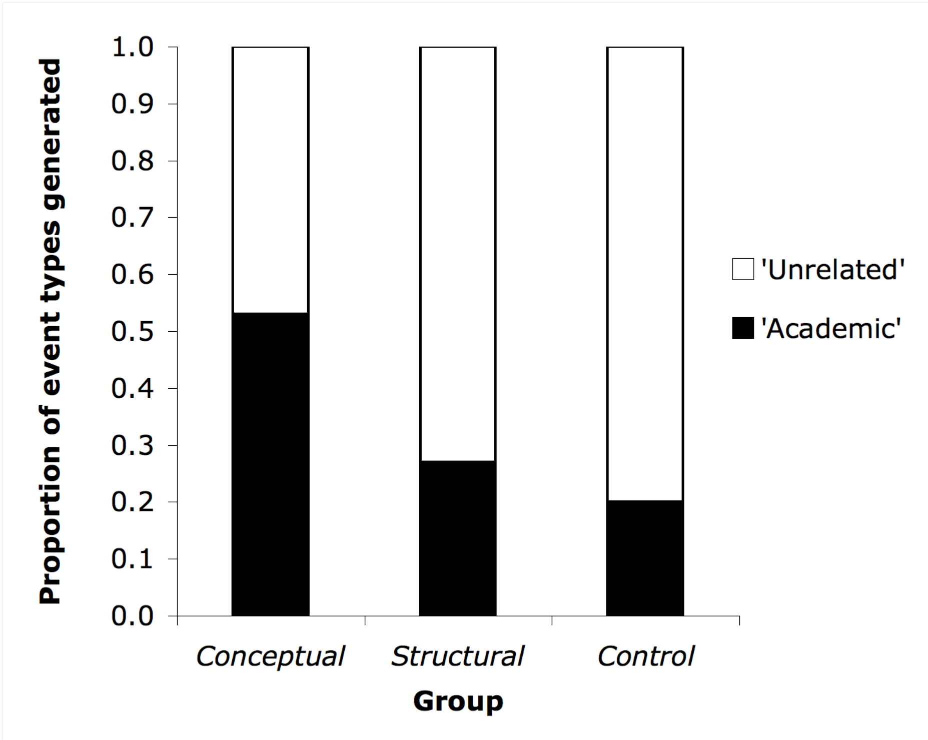

Figure 6. Results for Experiment 3. Proportion of event types generated as a function of priming condition. Relative to the *control* group, participants in the *conceptual* group generated more academically relevant future thoughts. Conversely, participants in the *structural* group did not differ from those in the *control* group.

events generated by participants in the *control* group (i.e., 6 'academic' scenarios and 24 'unrelated' scenarios), $\chi^2 < 1$. Importantly, participants in the *structural* group were found to spend a statistically similar amount of time completing their sentence task (i.e., counting vowels) as those in the *conceptual* group (who constructed meaningful sentences) (*M*s = 6752 ms and 6552 ms, respectively; $t < 1$). Hence, the lack of priming for the *structural* group, relative to the *conceptual* group, may be attributed to the absence of meaning-based processing of the sentence stimuli.

Discussion

The results of this experiment show clearly that conceptual processing moderates the relationship between priming and episodic future thought. Specifically, participants in the *conceptual* group were more likely to generate future episodes related to academic activities than those in the *control* group. Moreover, the *structural* and *control* groups did not differ from one another (cf. Srinivas & Roediger, 1990).

General Discussion

When one is cued to think about a personal future episode (either in daily life or in the laboratory) a specific scenario often comes to mind. This prominent feature of episodic future thought is so familiar to those who possess the capacity that it may seem trivial. However, there exists a large amount of personal knowledge that is relevant to any given cue to think about the future. As such, there must exist some underlying cognitive mechanisms that determine which knowledge becomes incorporated. Here, the results of three experiments suggest that knowledge accessibility may represent one such mechanism. Next, we will relate these findings to the relevant literature and discuss their broader implications.

Knowledge Accessibility and its Relation to Future Thought

The idea that knowledge accessibility might have an influence over the nature of one's thoughts about the future is reminiscent of the role of heuristics and biases in human decision-making (Tversky & Kahneman, 1973). In particular, Tversky and Kahneman showed that participants' estimates of the likelihood with which various events would occur in the future were influenced by the ease with which similar examples were retrieved from memory. For example, when asked to estimate the probability that one's car will be stolen in the future, people who have had experiences with car theft (either personally or vicariously) will estimate a higher probability of future car theft than those with little prior experience. The authors referred to this process as the *availability heuristic*. Moreover, Tversky and Kahneman suggested that a similar heuristic might be at work when people think about rare events for which there may be no relevant memories to draw upon. Specifically, the authors suggested that in thinking about unique events people generate hypothetical scenarios, and the ease with which such scenarios come to mind influences the estimated likelihood of their occurrence. This particular process was later referred to as the *simulation heuristic* (Kahneman & Tversky, 1982). Importantly, both heuristics denote a close relationship between knowledge accessibility and future thinking. That is, in both cases, accessible knowledge becomes cognitively available and people are likely to base their judgments of future probability on that information (and how effortlessly it comes to mind; Schwarz, Bless, Wanke, & Winkielman, 2003).

It is proposed that a similar principle underlies the mental construction of episodic future thought. Specifically, the contents of episodic future thought seem, at least in part, to be shaped by readily accessible knowledge that is relevant to a personal future episode that one has in mind. In the current experiments, participants were more likely than would be expected by chance to generate future episodes that were congruent with relevant information that they had experienced in the context of an earlier task. In Experiment 1, for instance, participants were asked to think about a personal future episode that might occur on or near their school campus within the next week. Given this specific set of constraints, the knowledge that participants could use to generate a scenario (e.g., information related to settings, people, and objects) was effectively delimited. It was then possible to examine whether priming information relevant to one type of event (e.g., an academic situation) relative to another (e.g., a social situation) would shape the content of participant-generated episodes. Relative to a control group, participants who had been primed to think about information relevant to academic or social situations were more likely to generate academic or social scenarios, respectively. This general pattern of results was replicated and extended upon in Experiment 2. Specifically, in Experiment 2 the relevant knowledge base was further delimited by employing one additional constraint. That is, participants were asked to think about a personal future episode that might occur on or near their school campus within the next week and that was related to an academic situation. Relative to a control group, participants who had been primed to think about information relevant to academic situations occurring inside or outside the classroom were more likely to generate academic scenarios occurring inside or outside the classroom, respectively.

In both experiments, participants were asked to use scrambled arrangements of words (e.g., fun the was party boring) to construct sentences that were most relevant to them (e.g., 'the party was fun' versus 'the party was boring'). How is it that this priming task was so effective in shaping the theme of a personal future episode? At this juncture, it might be premature to make any claims that go beyond the argument that engaging in the meaningful processing (cf. Experiment 3) of information relevant to an upcoming open-ended production task (episodic future thought, in this case) will shape the content of that task. For instance, it will be interesting for future research to examine whether similar effects might be obtained with various other priming materials (e.g., pictorial stimuli). Notwithstanding, some insights were gained from an informal post-experiment interview.[1] Specifically, participants tended to report that they used whatever personal experiences came to mind to help them decide how to complete each sentence (e.g., deciding whether a fun or boring party was more pertinent to them). Hence, participants who were primed to think about information relevant to a particular type of situation (e.g., social) brought to mind relevant personal information that subsequently enhanced the likelihood of imagining a related experience occurring in the future. In other words, perhaps the nature of the priming materials used is not as important as the information that participants associate with those materials. Prior research has shown that similar events take place in one's recent past and future (D'Argembeau & Van der Linden, 2004; Spreng & Levine, 2006; Szpunar & McDermott, 2008). Hence, recent experiences may provide a particularly useful source of information when thinking about upcoming events. Of course, future research will need to more systematically evaluate these claims.

On the basis of the present results, it is reasonable to assume (given a particular cue to think about the future) that knowledge accessibility fluctuates over time and that the exact content of episodic future thought will depend, in part, on the timing of the thought. It will be interesting for future research to further examine the specificity of this effect. For instance, all things being equal, is one more likely to imagine *the same event* in a particular setting, or incorporate a particular individual or object, based on their recent experiences? The present results suggest that this should be the case. Importantly, no assumptions are made regarding the nature of the underlying knowledge that is evoked in the construction of episodic future thought. That is, this knowledge may be semantic, episodic, or any other form (cf. Forster & Liberman, 2007; Higgins, 1996), as long as it is relatively accessible (Szpunar, in press).

Thus far, discussion has focused on knowledge that is made temporarily accessible through recent thought about relevant information. That is not to say, however, that other sources of accessibility do not exist. For instance, research on impression formation has shown that some knowledge structures may be *chronically* accessible as a result of either stable personality characteristics (Bargh, Bond, Lombardi, & Tota, 1986; Bargh & Thein, 1985; Higgins & Brendl, 1995; Higgins, King, & Mavin, 1982) or frequent priming (of those knowledge structures) in the laboratory (Higgins, Bargh, & Lombardi, 1985; Lombardi, Higgins, & Bargh, 1987). In general, chronically accessible knowledge structures appear to exert more long-term influences on impression formation than temporarily accessible knowledge structures (for a review see Higgins, 1996). It is certainly feasible that similar principles apply to episodic future thought. For instance, some aspects of knowledge may be chronically accessible in relation to a specific future event if they have been frequently associated with thoughts about similar future events in the past. Perhaps one good place to begin this particular line of inquiry would be to examine the relation between frequency of priming and the retention interval separating priming from episodic future thought.

As is the case with any new area of research, the answer to one question opens the door for many others. For instance, questions related to potential issues regarding priming materials, frequency of priming, and the delay between priming and episodic future thought have already been considered. Each of these questions revolve around the theme of knowledge accessibility in episodic future thought and point to avenues through which the present findings may be extended in the future. Next, we will shift focus and consider what occurs during the episodic future thought task itself. Until now, there has been an almost implicit assumption in the literature that episodic future thought evokes mental simulation (Schacter & Addis, 2007; Schacter, Addis, & Buckner, 2007, 2008; Szpunar, in press). However, there exist no direct data to corroborate this claim. A better understanding of the level of representation that underlies episodic future thought will be necessary for understanding the relation between episodic future thought and knowledge accessibility. Some directions for future research are considered below.

Future Directions: Mental Simulation and Episodic Future Thought

Evidence in support of the assumption that episodic future thought evokes mental simulation may be derived from two sources: 1) neuroimaging data showing that episodic future thought engages neural regions responsible for visual-spatial processing (Addis, Pan, Vu, Laiser, & Schacter, in press; Addis et al., 2007; Botzung et al., 2008; Okuda et al., 2003; Szpunar et al., in press; Szpunar et al., 2007) and simulation of bodily movements (Szpunar et al., 2007), and 2) subjective reports (e.g., D'Argembeau & Van der Linden, 2004, 2006). However, arguments against these particular sources of evidence may be easily raised. First, no neuroimaging study of episodic future thought has been conducted to directly test this assumption. Thus, while the extant neuroimaging literature may suggest that episodic future thought engages regions associated with mental simulation, specific studies will need to be conducted in order to provide more substantive data. One potential approach might be to query a priori regions of interest that have been identified in the mental simulation literature (e.g., Decety & Grezes, 2006; Grezes & Decety, 2001; Hesslow, 2002) and examine what patterns of activity are associated with episodic future thought in those regions. Second, although subjective reports are informative, they will need to be backed up by behavioral data. To date, no such behavioral studies have been conducted. Although we await such work, some preliminary considerations can be made with the situation model literature in mind.

Thinking About Events: Situation Models

Much of what one reads, hears, and thinks about in their daily life has to do with situations. For instance, whether one is reading an interesting story in a newspaper article or listening to a friend retell a story about a recent weekend, one learns about a series of interconnected events that constitute a specific situation. What mechanism underlies the ability to comprehend situations inherent in discourse? Is the same mechanism involved regardless of the modality through which information about situations is learned? Next, we will consider evidence that discourse comprehension is aided by the construction of high-level (referential) mental representations, namely situation models.

The ability to understand a described set of circumstances has been considered extensively in studies that examine memory for language and text. Specifically, researchers in this field have advanced the idea that memory for language and text involves three levels of representation: 1) the surface form (i.e., memory for specific words and syntax), 2) the propositional textbase (i.e., memory for ideas conveyed that are independent of wording), and 3) the situation model (i.e., memory for the described situation). For present purposes, we will focus on mental representations at the level of the situation model (see Johnson-Laird, 1983; van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998).

In their seminal study, Bradsford, Barclay, and Franks (1972) presented participants with sentence stimuli such as “Three turtles rested on a log and a fish swam beneath them.” In a later recognition phase, participants were likely to misidentify the sentence “Three turtles rested on a log and a fish swam beneath it” as having been studied in the exposure phase. The authors claimed that the effect occurred because both sentences describe the same situation. In contrast, participants were less likely to make the error when presented with the sentence “Three turtles rested beside a log and a fish swam beneath them” in the exposure phase and the sentence “Three turtles rested beside a log and a fish swam beneath it” in the recognition phase. Although this latter pair of sentences also differed by only one word (i.e., *them* or *it*), the situations described by these sentences were decidedly different. This pattern of results suggested that participant’s memories for text were guided by the described situation and not by the language itself (see also Glenberg, Meyer, & Lindem, 1987).

Since then, a considerable amount of research has shown that people form multidimensional situation models that aid in the comprehension of discourse. Among the various components of situation models that have received empirical attention are spatial-temporal frameworks (i.e., the location in space and time, or context, in which an event tasks place), tokens and their interrelations (i.e., the relevant people and objects that are embedded within a specific spatial-temporal framework, their relevant properties, spatial arrangement, and so on), and linking relations among a series of spatial-temporal frameworks (e.g., temporal, casual) (for a detailed review see Zwaan & Radvansky, 1998; for a more recent discussion see Radvansky, 2008).

According to Radvansky (2008), situation models are “mental simulations” (p. 230) of a described set of circumstances (see also Zwaan, 1999). Of course, that claim does not necessarily mean that people construct life-like (or image-based) mental representations in their minds when processing discourse (cf. McKoon & Ratcliff, 1992). Rather, most researchers in this field subscribe to the view that discourse comprehension is aided by the construction of high-level, abstract, mental representations of situations (cf. Barsalou, 1999). This view is supported by findings that comprehension performance is highly similar across modality. For instance, Baggett (1979) found that participants who viewed a short film depicting a series of events produced structurally similar recall protocols as participants who heard a spoken version of the story. In another study, Gernsbacher, Varner, and Faust (1990) found that comprehension of various forms of discourse (e.g., reading, listening, viewing) was highly correlated within participants. That is, participants who were good at comprehending written materials were also good at comprehending auditory materials, and so on. This latter finding makes little sense if one assumes that participants in this experiment only created a mental representation of the discourse itself. However, it makes sense if one assumes that participants constructed higher-level representations of the situations described in the discourse (irrespective of modality).

Relevance to Episodic Future Thought

On the basis of the evidence that people generate high-level, abstract, representations about the situations that they read and hear about, it does not seem too much of a stretch to suggest that people may rely upon a similar mechanism when thinking about the situations they generate in the course of episodic future thought. By definition, episodic future thought involves thinking about specific events, or situations, that one might potentially encounter in their personal life (Szpunar, in press). While there exists no experimental evidence to corroborate this claim, simply examining participant generated protocols of future scenarios provides some clues. For instance, consider again the scenario generated by the sample participant in Table 1. The sample participant generated a scenario that took place in a specific spatial-temporal framework (i.e., a familiar beach), involved various tokens and their interrelations (e.g., the participant's friends, beach ware; spatial relations between people and objects), and contained various linking relations that served to connect a series of events into a coherent representation of one specific scenario (i.e., the participant described a series of events that will occur, one after the other, in the course of spending a day on the beach). It will be interesting for future research to examine whether these features of episodic future thought are mentally represented in a way that complements relevant work in the situation model literature. With regard to knowledge accessibility, if it turns out that certain materials are better able to prime episodic future thought, then it will be informative to have a clear understanding of how participants are representing those thoughts.

Concluding Remarks

The present findings are meant to represent an initial step towards a more complete understanding of the capacity for the human mind/brain to flexibly (re)organize knowledge in the construction of personal future episodes. Although it is clear that there is much to learn about episodic future thought, two important points deserve mention. First, episodic future thought represents a cognitive capacity that is amenable to inquiry in the behavioral laboratory. Much of our current understanding of episodic future thought has been gained through studies conducted with patient populations and neuroimaging techniques. Although these approaches will doubtless continue to provide insights into this fascinating capacity, examining episodic future thought from a behavioral standpoint will also be informative and useful. Second, episodic future thought shares features in common with other cognitive tasks. Drawing upon those relations helped to provide insight and justification for conducting the current set of experiments. Moreover, the outcome of these experiments revealed that principles that have previously been identified with tasks that might arguably lack ecological validity (e.g., name the first eight animals that come to mind) hold in the context of a mental activity that people engage in on a daily basis (D'Argembeau, Renaud, & Van der Linden, 2009). Such comparisons emphasize the importance of examining the relations between tasks that often times receive little crosstalk but that may, when examined together, highlight underlying principles of cognitive functioning.

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Footnote

[1] The final 55 participants who were run in the present set of three experiments were asked to identify any strategies that they might have engaged in to help them to construct sentences from the scrambled arrangements of words.

Appendix A

Partial transcript of informal interview

--A personal future episode from a sample participant (Table 1)--

Question about general event

Experimenter (E): Why do you think you thought about this specific event?

Participant (P): I've been thinking a lot lately about taking a vacation with some of my friends this summer. It will be the last chance we'll have for fun before graduate school.

Questions about setting

E: Why do you think this event occurred where it did?

P: Well, I'd like to take a trip somewhere that has a nice beach. Nice was the first place that came to mind.

E: How familiar are you with this specific location?

P: Well, I've been to Nice before so…pretty familiar.

E: How many times have you been to the particular beach you imagined?

P: Just once. Last time I was there, we spent a short time at the beach and I remember wanting to go back one day.

E: Why do you think you specifically imagined being on the beach and not doing something else, like site seeing?

P: I guess it's because I want to take a vacation to a place where I can just sit back in the sun. But, of course, I'll want to do other things while I'm there. That city is something else.

Appendix B

Scrambled word cues (and sample completions)

Social situations (6) – Experiment 1

1) movies group the watched television (e.g., the group watched movies)
2) fun the was party boring (e.g., the party was fun)
3) played friends cards sports the (e.g., the friends played sports)
4) lunch the dinner roommates ate (e.g., the roommates ate dinner)
5) was workout their short long (e.g., their workout was long)
6) pleasant date was awkward the (e.g., the date was pleasant)

Academic situations (6) – Experiments 1 and 3

1) teacher the quickly spoke slowly (e.g., the teacher spoke slowly)
2) interesting lecture the was boring (e.g., the lecture was interesting)
3) class late the early ended (e.g., the class ended early)
4) night all studied procrastinated he (e.g., he studied all night)
5) was homework the easy hard (e.g., the homework was easy)
6) library the peaceful was noisy (e.g., the library was noisy)

Classroom situations (6) – Experiment 2

1) teacher the quickly spoke slowly (e.g., the teacher spoke quickly)*
2) interesting lecture the was boring (e.g., the lecture was interesting)*
3) class late the early ended (e.g., the class ended early)*
4) took notes she skimpy detailed (e.g., she took detailed notes)
5) ignored the teacher questions answered (e.g., the teacher answered questions)
6) student was lecturer the presenting (e.g., the student was presenting)

* same as Experiments 1 and 3

Non-classroom situations (6) – Experiment 2

1) night all studied procrastinated he (e.g., he studied all night)*
2) was homework the easy hard (e.g., the homework was easy)*
3) library the peaceful was noisy (e.g., the library was noisy)*
4) her long short was essay (e.g., her essay was short)
5) memorized notes she her rehearsed (e.g., she memorized her notes)
6) uninteresting the was uninteresting book (e.g., the book was interesting)

* same as Experiments 1 and 3

Control cues (18) – Experiments 1, 2, and 3

1) is boy the tall short (e.g., the boy is tall)
2) sad girl the happy is (e.g., the girl is happy)
3) rabbit cute is ugly the (e.g., the rabbit is cute)
4) the rude is kind man (e.g., the man is rude)
5) is cut the grass green (e.g., the grass is green)
6) small plane the large is (e.g., the plane is large)
7) weak chair the is sturdy (e.g., the chair is sturdy)
8) hard ball is the soft (e.g., the ball is soft)
9) stopped the suddenly skidded car (e.g., the car stopped suddenly)
10) fast slow tractor is the (e.g., the tractor is slow)
11) young woman felt the old (e.g., the woman felt young)
12) object is the heavy light (e.g., the object is light)
13) the is old new clock (e.g., the clock is new)
14) is snake the long short (e.g., the snake is long)
15) flew kite high far the (e.g., the kite flew high)
16) orange is yellow boat the (e.g., the boat is yellow)
17) is window the clean dirty (e.g., the window is clean)
18) full box is the empty (e.g., the box is full)

Appendix C

Episode Generation Instructions

Experiments 1 and 3

In the space below, please describe an event involving you somewhere on or near campus within the next week. This can be about anything, so long as it involves you somewhere on, or close to, campus. Just describe the first event that comes to mind. Please describe where the event takes place and what is happening.

Experiment 2

In the space below, please describe an academically relevant event involving you somewhere on or near campus within the next week. This can be about anything, so long as it involves you on, or close to, campus doing something related to your schooling. Just describe the first event that comes to mind. Please describe where the event takes place and what is happening.