The Quarterly Journal of Experimental Psychology

ISSN: 1747-0218 (Print) 1747-0226 (Online) Journal homepage: http://www.tandfonline.com/loi/pqje20

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To cite this article: Aline Cordonnier, Amanda J. Barnier & John Sutton (2016) Scripts and information units in future planning: Interactions between a past and a future planning task, The Quarterly Journal of Experimental Psychology, 69:2, 324-338, DOI: 10.1080/17470218.2015.1085587

To link to this article: http://dx.doi.org/10.1080/17470218.2015.1085587

Accepted author version posted online: 26 Aug 2015.
Published online: 27 Oct 2015.

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THE QUARTERLY JOURNAL OF EXPERIMENTAL PSYCHOLOGY, 2016
Vol. 69, No. 2, 324–338, http://dx.doi.org/10.1080/17470218.2015.1085587

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Scripts and information units in future planning: Interactions between a past and a future planning task

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(Received 17 March 2015; accepted 29 July 2015; first published online 27 October 2015)

Research on future thinking has emphasized how episodic details from memories are combined to create future thoughts, but has not yet examined the role of semantic scripts. In this study, participants recalled how they planned a past camping trip in Australia (past planning task) and imagined how they would plan a future camping trip (future planning task), set either in a familiar (Australia) or an unfamiliar (Antarctica) context. Transcripts were segmented into information units that were coded according to semantic category (e.g., where, when, transport, material, actions). Results revealed a strong interaction between tasks and their presentation order. Starting with the past planning task constrained the future planning task when the context was familiar. Participants generated no new information when the future camping trip was set in Australia and completed second (after the past planning task). Conversely, starting with the future planning task facilitated the past planning task. Participants recalled more information units of their past plan when the past planning task was completed second (after the future planning task). These results shed new light on the role of scripts in past and future thinking and on how past and future thinking processes interact.

Keywords: Future thinking; Planning; Memory; Scripts; Mental time travel.

The future might be unknown, but it is predictable to some extent. Events tend to repeat themselves, people do not change drastically over time, and the laws of physics continue to operate in day-to-day life. This continuity of the self and of the world provides us with the framework needed to think about the future. With memories and knowledge as building blocks, humans have been shown to successfully simulate future events and to predict outcomes or plan actions in order to achieve specific goals (Atance & O'Neill, 2001). For example, a job seeker going to an interview might simulate the questions he will be asked, drawing both on similar past experiences and on specific knowledge of the company and the offered position; a teenager can predict how her parents will react if they find out she lied about her test results; or a couple may discuss a plan for the different steps needed to build their

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We want to thank M. Irish for some helpful clarifications, as well as the anonymous reviewers for their constructive comments and suggestions, which have helped improve this manuscript.

This work was supported by a Macquarie University Research Excellence Scholarship to Aline Cordonnier; by an Australian Research Council (ARC) Discovery Project and ARC Future Fellowship to Amanda Barnier; by an ARC Discovery Project to John Sutton; and by the Memory Program of the ARC Centre of Excellence in Cognition and its Disorders and the Department of Cognitive Science, Macquarie University.

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house. During the course of one day, people think about the future as often as they think about the past (Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2012), with on average 60 future-oriented thoughts a day (D'Argembeau, Renaud, & Van der Linden, 2011).

Even though future thoughts are as common as memories in our daily life, our capacity to remember has received significantly more scientific attention than our capacity to think about the future. But in the last 20 years, researchers have shown an increased interest in future thinking, specifically in one particular aspect of it: *episodic future thinking* (also known as episodic foresight, episodic simulation, or prospection; for reviews, see Klein, 2013; Schacter, 2012; Szpunar, 2010). Episodic future thinking is usually defined as the capacity to project oneself into the future, and it is often studied in parallel with episodic memory for three principal reasons (Dudai & Carruthers, 2005; Schacter & Addis, 2007; Suddendorf & Corballis, 1997). First, the two phenomena partially rely on the same component processes and neural mechanisms (Addis, Musicaro, Pan, & Schacter, 2010; Addis, Pan, Vu, Laiser, & Schacter, 2009; D'Argembeau, Xue, Lu, Van der Linden, & Bechara, 2008; Tulving, 1985). Second, they draw on the same information stored in our episodic and semantic memory (Atance & O'Neill, 2001; Buckner & Carroll, 2007; Klein, Cosmides, Tooby, & Chance, 2002; Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 2007). Third, researchers also have argued that thinking about the future is one of the major functions of memory (Klein, 2013; Schacter, 2012; Schacter et al., 2012; Suddendorf, Addis, & Corballis, 2009; Tulving, 2005).

Thinking about a future event can take many forms. A thought-sampling study showed that in everyday life, future thoughts served a wide array of functions such as dreaming about one's future, simulating an upcoming event, or making decisions (D'Argembeau et al., 2011). Notably, more than half of self-reported future thoughts were related to *planning* an event or an action (see also Baird, Smallwood, & Schooler, 2011). In their recent taxonomy, Szpunar, Spreng, and Schacter (2014) defined four different modes of future thinking, namely simulation, prediction, intention and planning, and divided each mode into three forms (episodic, semantic, or hybrid). Similarly, in our own cognitive framework (Cordonnier & Sutton, 2016), we also identify four main processes of thinking about a potential upcoming event: (a) imagining, which does not entail any belief that the future event might happen; (b) simulating or predicting, which imply that the event will probably occur; (c) planning, a multicomponent goal-directed process that includes simulating the different steps and their consequences; and (d) forming and remembering intentions, also known as prospective memory. We distinguish these different forms of future thinking by the temporal distance between the moment the event is thought of and its possible realization, and by the subjective plausibility of the thought event. We also argue that the content of the future thoughts might rely more or less on episodic or on semantic memory depending on the accessibility of memories of similar past events, as well as on the sought plausibility of the thought future event.

However, the majority of studies to date have focused on how participants imagine future events without taking into account how plausible or probable they might be. Instead, research has emphasized the role of episodic details, influenced by the constructive episodic simulation hypothesis, which suggests that humans recombine episodic details from past events to simulate future ones (Schacter & Addis, 2007, 2009). This episodic focus can be observed at two levels: in experimental methods and in coding schemes. In terms of method, participants generally are instructed to imagine and describe specific episodic future events, cued with time periods such as "in five years" or "when you will retire" (e.g., MacLeod & Conway, 2007), with nouns such as "dog" or "birthday" (e.g., Addis, Wong, & Schacter, 2007; D'Argembeau & Demblon, 2012), or with a set of idiosyncratic cues, as in the episodic recombination paradigm (Addis et al., 2010; Addis, Pan, et al., 2009). Consequently, although the events produced by these different styles of cues are all imagined future events, their content, as well as their plausibility, may differ substantially contingent on the cue and the instructions received. Time period cues, especially when set in the distant future, would most likely trigger cultural life script events that might be highly plausible but lack episodic specificity (Berntsen & Bohn, 2010); noun cues might prompt mundane or repeated events; whereas idiosyncratic cues, as in the recombination paradigm, might potentially generate unlikely events that score high on episodic specificity but low on plausibility. In our research, we wanted to examine the use of episodic and semantic memory in plausible future thoughts. Following our framework, we thought that investigating future planning could help us achieve this goal.

In terms of coding schemes that specify and quantify details in transcripts of past and future thinking, episodic details have usually been regarded as more important than other types of details. One of the most widely used coding schemes concentrates on the quantity of internal (or episodic) details that participants generate while remembering past events or imagining future ones (e.g., Addis, Wong, & Schacter, 2008; Cole, Morrison, & Conway, 2013; De Brigard & Giovanello, 2012; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). Any detail not considered internal is labelled external. External details include: repetitions, other episodic details not relevant to the specific episodic event, and semantic details. A reduction in internal details (often accompanied but not correlated with an increase of external details) has been interpreted either as an indication of age-related changes in older adults (Addis et al., 2008; Cole et al., 2013) or as symptomatic of memory deficits in patients with hippocampal damage (Addis, Sacchetti, Ally, Budson, & Schacter, 2009; Hassabis, Kumaran, & Maguire, 2007; Klein, Loftus, & Kihlstrom, 2002; Tulving, 1985). It is also important to note that to code for these internal and external details, the procedure requires identifying a clear central episodic event. This step can only be completed in episodic tasks; other types of future thinking, such as planning, cannot be analysed using this procedure.

If episodic details have been considered central in future thinking, a number of recent studies, although differing in aim and method, support the claim that semantic memory is also important for the simulation of future events and, in all likelihood, provides the scaffolding needed to give meaning and structure to the simulated event (Szpunar, 2010). D'Argembeau and Mathy (2011) explored the construction of mental representations of future events by asking healthy participants to report their thought flow while imagining specific future events. Participants usually first reported personal semantic information and/or general events before producing specific episodic details. Also, cueing them with personal goals facilitated the production of future events as well as access to episodic details. Cole, Gill, Conway, and Morrison (2012) examined the effect of trial duration on the production of episodic and semantic details. They showed that the amount of semantic details in past and future thinking was not related to the amount of episodic details, which indicates that semantic details are not generated at the expense of episodic details. Irish, Addis, Hodges, and Piguet (2012) investigated the role of semantic knowledge in past and future thinking by testing patients with semantic dementia. Irish et al. found that while these patients demonstrated intact retrieval of recent memories, they showed a compromised capacity to simulate novel events in the future. Neuroimaging results revealed that future thinking deficit in these semantic dementia patients was strongly correlated with atrophy in the anterior temporal lobes, which are critical for the representation of semantic knowledge (Irish et al., 2012). Interestingly, there also have been instances of patients with hippocampal amnesia who have shown preserved ability to imagine future events (Maguire, Vargha-Khadem, & Hassabis, 2010; Mullally, Hassabis, & Maguire, 2012). Together, these findings speak to the importance of semantic representations, such as general semantic knowledge but also personal semantics and semantic scripts, in the construction and simulation of future events. This has led Irish and Piguet (2013) to propose a new hypothesis—the semantic scaffolding hypothesis—which suggests that semantic memory helps scaffold both past and future thinking.

While the constructive episodic simulation and the semantic scaffolding hypothesis agree that episodic and semantic memory contribute to future thinking, the former emphasizes the role of episodic details whereas the latter emphasize the importance of semantic information to provide the framework of the event, which is then populated by episodic details and semantic knowledge depending on familiarity. Familiar events would more likely draw upon episodic details, whereas unfamiliar or novel events would more likely draw upon semantic knowledge and scripts. However, distinguishing the separate contribution of episodic and semantic memory can be challenging, mainly because the distinction between the two is not always well defined. For example, scripts, defined by Schank and Abelson (1977, p. 210) as "a structure that describes appropriate sequences of events in a particular context", are categorized as semantic memory but can derive from repeated episodic experiences (Abelson, 1981; Bower, Black, & Turner, 1979; Hudson, Fivush, & Kuebli, 1992; Nelson & Gruendel, 1981). As it scaffolds and cues episodic remembering, script knowledge becomes intertwined with episodic details in an almost indistinguishable way. Although scripts have been shown to support the remembering process, even more so when recalling goal-directed events (Lichtenstein & Brewer, 1980), we suggest their particular structures make them essential for any type of future thinking requiring the event to have a good level of plausibility. They provide knowledge of how events tend to unfold, and can be derived both from semantic knowledge and from episodic memories, especially when they are about recurring events. However, research on future thinking has yet to integrate scripts into analysis, as they cannot be coded with the traditional internal/external coding scheme. For example, when analysing a restaurant script, what matters is not specific details such as what food was selected on the menu or how the bill was paid; what is important is that the person considered these topics. Therefore, one way to investigate scripts is to compare higher order categories of details regardless of specific content.

In this introduction, we have discussed the need to expand research on future thinking by considering the role of scripts in plausible future events, depending on familiarity of the context. Therefore, in our study, we created a novel experimental paradigm that focused on the mental simulation of planning, which means we used planning as the content of both the remembering and imagining tasks (participants remembered planning a past event or imagined planning a future one). This was done for three reasons. First, planning is an important part of our daily life and seems to be a major aspect of future thinking (Baird et al., 2011; D'Argembeau et al., 2011). At the same time, planning has evolutionary benefits (Klein, 2013; McCormack, Hoerl, & Butterfill, 2011) and is regarded as an important developmental achievement, with many studies investigating planning in children (McCormack & Atance, 2011). Indeed, being able to simulate and anticipate what could occur as well as the consequences for our actions offers a unique advantage in our day-to-day lives. This makes it ideal for expanding research on future thinking, as our design might capture aspects of real-life future thinking not yet tapped by other paradigms.

Second, future planning is a multicomponent goal-directed process (Hayes-Roth & Hayes-Roth, 1979). However, we wanted to look at one particular component of the process that relates more to episodic future thinking: simulation of the planning (Szpunar et al., 2014). Unlike other aspects of future thinking, such as daydreaming, planning requires anticipation of the future by inferring how things might plausibly unfold in a given situation. To do so, one needs general knowledge of the context of the event, of the causal relationships between actions and their consequences, and even knowledge about one's own self and others. An easy way to obtain this knowledge is to bring to mind a similar situation that has been encountered previously and compare it to the current one. Therefore, using planning as the content of the simulation allowed us to constrain and control the type of content in each telling to make it comparable across tasks, and to examine how a past planning experience influences the planning of a similar future event.

Finally, scripts can be of great value in successful planning, especially when no comparable event has been planned before, and the context is unfamiliar. They provide general knowledge about the sequences of events that can be expected in a given situation, regardless of personal experience. Consequently, it gave us the opportunity to explore the use of scripts in past thinking and future thinking in familiar but also unfamiliar contexts.

To investigate how participants rely on past memories and on semantic scripts to simulate planning a future event, we divided our experiment into two tasks. We asked participants to remember how they planned a past camping trip and how they imagined they would plan a future one. The past camping trip was always set in Australia (as all our participants had been on a camping trip in Australia) whereas the context of the future trip was either identical to the past planning task—in Australia—or totally new to the participant—in Antarctica. This last condition (imagining how to plan a camping trip in Antarctica) was created to explore the construction of future thoughts when participants could not rely on an episodic recollection of having planned a similar event in the past. To the best of our knowledge, the only study investigating the quantity of details in familiar and unfamiliar future events found that familiar events contained more internal details than unfamiliar events (de Vito, Gamboz, & Brandimonte, 2012). However, scripts and semantic knowledge might have a bigger role to play in future planning than in future simulation. If so, we would expect participants to provide as many details in familiar and unfamiliar context by relying on scripts, and that these scripts would be similar in past and future thinking tasks. Furthermore, as we counterbalanced the order of presentation of the tasks, we hypothesized that past and future planning scripts in a familiar context would be more alike when the past planning task was completed first.

EXPERIMENTAL STUDY

Method

Participants

We recruited 40 undergraduate university students (28 female and 12 male, mean age = 20.05 years, $SD = 2.42$; range = 18–30 years) enrolled in an introductory psychology course at Macquarie University (Sydney, Australia) as participants for this experiment. We selected them from a participant pool if English was their first language, and they had been on a camping trip in Australia in the past 5 years. They gave informed consent prior to testing, including agreement to be audio recorded, and received course credit as compensation for their time, in accordance with the Macquarie University Ethics Committee.

We tested participants in a 2 (task order: past planning first, then future planning vs. future planning first, then past planning) × 2 (familiarity of future planning context: familiar, Australia vs. unfamiliar, Antarctica) mixed design.

Materials and procedure

Upon arrival, participants gave their consent and received the following instructions:

> You will carry out two main tasks followed by some questions. One of the tasks consists of remembering how you planned a past event; the other consists of imagining how you would plan a future event. I will ask you to tell me your answers out loud, so I can record them, and then to write a summary of them.

For their first task, we randomly assigned participants to one of three scenarios, adapted from Klein, Robertson, and Delton (2010):[1] (a) *a past planning scenario*, where we told participants to remember the different steps they had to undertake

[1]We designed the paradigm in a way that would let us include a subtest at the end of the session replicating Klein et al. (2010)'s experiment. However, the condition of the testing and the sample size were relatively different from those in the original. As we did not replicate the results, we decided not to include them in this article. The data for the replication were collected after the data presented in this paper; therefore it cannot be considered as a confounding factor.

to successfully plan and prepare for their past camping trip in Australia; (b) *a future planning in a familiar context scenario*, where we told participants to imagine the different steps they would undertake to successfully plan and prepare for their future camping trip in Australia; (c) *a future planning in a unfamiliar context scenario*, where we told participants to imagine the different steps they would undertake to successfully plan and prepare for their future camping trip in Antarctica. Participants had 1 min to remember or imagine the planning before they described it to the experimenter for up to 5 min. We audiorecorded their answers using the freeware computer-recording programme Audacity. Subsequently, participants summarized their answer on a sheet of paper. Once they completed their summary, a distractor task was presented to them in the form of a set of mazes.

At the end of the distractor task, we gave participants a second scenario. If they received the past planning scenario (a) as their first task, they were given one of the two future planning scenarios (b or c); and if they received one of the two planning scenarios (b or c) as their first task, they were given the past planning scenario (a). In summary, each participant completed a past planning task and a future planning task that was set either in a familiar context or in an unfamiliar context. We counterbalanced the order of the tasks across participants. Therefore we had four conditions in total: "past then future—familiar future context (Australia)", "past then future—unfamiliar future context (Antarctica)", "future then past—familiar future context (Australia)", "future then past—unfamiliar future context (Antarctica)".

To conclude the experiment, participants completed a short questionnaire about their demographic details, camping habits, and knowledge of Antarctica. They also provided ratings on a 10-point Likert scale on how difficult they found both the past planning and future planning tasks. We then fully debriefed participants and thanked them for their time.

Data analysis

With help from the written summaries, we transcribed each audio recording. Because of the nature of our tasks but also because we wanted to investigate script similarities between past and future planning, we created a new coding scheme. We divided sentences into small segments, each containing one new piece of information or "information unit". To avoid inflating results, we scored adjectives and nouns in the same noun phrase as one single information unit (e.g., windproof jacket was scored 1). Then, we scored these information units according to a higher order semantic category (to record what the information unit was about), such as information about *who* would be coming, *where* they were planning to go, or the type of *material* they were going to bring. We also coded actions that needed to be undertaken and conditions (such as health conditions, time constraints, etc.) to take into account. Overall there were 19 semantic categories, which represented the type of information that could be found in a general script of how to plan a camping trip. These semantic categories were not chosen a priori but were derived from the data. We used a dynamic process of creating the coding scheme by adding new categories when needed and reanalysing the transcripts with the modified coding scheme until every information unit could be placed in a category. In the final analyses, we did not include repetitions (information units previously mentioned by participants), and we also excluded event details that were not related to the planning of the camping trips (such as details about how the trip itself went) as these details were only found in the past planning task and were not relevant to the planning itself.

The categories were: (a) who, (b) where, (c) when, (d) duration, (e) transport, (f) why, (g) weather, (h) money, (i) food, (j) accommodation, (k) personal items, (l) general material, (m) security concerns, (n) leisure activities, (o) chores, (p) seeking information, (q) general knowledge, (r) actions, (s) conditions. For example, the sentences "The *four of us* and *my little brother* planned to go camping *around Umina beach*, which is north of Sydney to learn how to surf. We decided to go by car and we would take Jack's tent." contain seven information units from six different semantic categories (in order): *who (×2)*, *where*, *general knowledge*, *why*, *transport,* and *accommodation*.

To check interrater reliability, the first author scored all transcripts, and one extra independent judge, blind to the aims of the study and trained on the coding technique, scored 53.75% of all transcripts (at least 50% in each condition). The initial agreement percentages were adequate (75.4%). Any discrepancy was resolved by discussion between coders until agreement.

These categories could be taken to constitute a complete script of what needs to be considered and done when planning a camping trip. A good planner would not necessarily provide more information units; however, they would provide information units coded under many different categories in order to cover the different steps of the plan. We therefore analysed both the total number of information units and the number of semantic categories mentioned in a transcript.

Furthermore, we wanted to analyse script similarity for each participant across the two tasks they completed. For example, if one participant considered place, time, food, weather, security, and leisure activities when planning his past trip, would he consider the same categories when planning his future trip? In other words, would participants retain a similar script of their plan, regardless of the specific content (e.g., food that you can cook on a fire vs. dry food that does not need to be cooked) and the quantity of information units (full list of items vs. mentioning planning for food), or would they provide information units from other categories depending on context? Therefore, we calculated for each participant the number of categories mentioned in both of their tasks, in their past planning task only, in their future planning task only, or in neither their past nor their future planning task.

Results

Camping experiences, knowledge of Antarctica, and difficulty ratings of the tasks

To ensure there was no discrepancy in prior knowledge and experience across conditions ("past planning then future planning in Australia, "past planning then future planning in Antarctica", "future planning in Australia then past planning", "future planning in Antarctica then past planning"), participants filled in a questionnaire about their camping experiences and general knowledge of Antarctica at the end of the study. There were no significant differences in the frequency of camping trips taken in Australia, how long ago was the camping they described in the past planning task, and their general knowledge of Antarctica (see Table 1). Therefore, subsequent differences between our conditions cannot be explained by differences in camping experiences or general knowledge of Antarctica.

Participants also rated how difficult they found both past and future planning tasks on a scale from 1 to 10. A 2 (task order) × 2 (familiarity of future planning context) univariate analysis of variance (ANOVA) revealed no significant differences for the self-rated difficulty of the past planning task ($M = 4.55$, $SD = 1.84$). However, there was a significant main effect for the self-rated difficulty of the future planning task when the context was unfamiliar to participants (Antarctica), $F(1, 36) = 4.88$, $MSE = 2.95$, $p = .034$, $\eta_p^2 = .119$. The future planning task was rated as more difficult when the scenario was set in Antarctica ($M = 5$, $SD = 1.95$) than when it was set in Australia ($M = 3.8$, $SD = 1.36$), regardless of the order the tasks were presented in. Finally, it is worth noting that participants did not find the past planning task easier or more difficult than the future planning task, $t(1, 39) = 0.51$, $p = .613$.

Quantity of information units produced in past and future planning tasks

First, we analysed the quantity of information units produced in past and future planning tasks. We removed two outliers (with a z score of at least +2.5) from the initial sample for this set of analyses.[2]

As participants rated the future planning task with the unfamiliar context (Antarctica) harder than the future planning task with the familiar

[2]One participant was in the "past planning then future planning in Antarctica" condition; the other was in the "future planning in Australia then past planning" condition. These two participants had a significant number of information units in a single category that inflated their total

Table 1. *Camping experiences, knowledge of Antarctica, and difficulty ratings of the tasks, as a function of the task order and the future scenario familiarity*

Measure		*Task order*				*Significant differences*
		Past–future		*Future–past*		
		Future scenario familiarity				
		Familiar (n = 10)	*Unfamiliar* (n = 10)	*Familiar* (n = 10)	*Unfamiliar* (n = 10)	
No. of participants for each frequency of camping trips taken in Australia	Rarely (1–3)	4	3	3	3	*ns*
	Often (4–6)	3	3	3	3	*ns*
	Regularly (7+)	3	4	4	4	*ns*
How long ago was the camping they described in the experiment (months)		27.2 (24.5)	19.3 (17.0)	28.1 (14.9)	34.3 (23.9)	*ns*
Knowledge of Antarctica (10-point scale)		2.5 (1.4)	4.3 (1.8)	4 (1.7)	3.5 (1.7)	*ns*
Difficulty of the past planning task (10-point scale)		4.6 (1.3)	5.0 (2.0)	3.8 (1.8)	4.8 (2.1)	*ns*
Difficulty of the future planning task (10-point scale)		3.7 (1.5)	4.8 (2.0)	3.9 (1.3)	5.2 (2.0)	*

*$p < .05$.

context (Australia), we started by comparing the average number of information units produced in the two future planning scenarios only. A 2 (task order) × 2 (familiarity of future planning context) univariate ANOVA revealed no main effect of task order, but more importantly, no main effect of the familiarity of the future scenario, $F(1, 34) = 1.02$, $MSE = 153.10$, $p = .320$. However, there was a significant two-way interaction between task order and familiarity of the context, $F(1, 34) = 6.06$, $MSE = 153.10$, $p = 0.019$, $\eta_p^2 = .15$.While there was no difference in quantity of information units produced between the two contexts (Australia and Antarctica) when the future planning task was completed first, participants provided fewer information units when the future planning task was completed second and when the context was familiar (Australia), $F(1, 34) = 6.03$, $MSE = 153.10$, $p = .019$, $\eta_p^2 = .19$.

Subsequently, we investigated the difference in quantity of information units produced in each task. We ran a mixed-design ANOVA with type of task (past planning vs. future planning) as a within-subject factor and task order (past–future vs. future–past) and familiarity of future planning context (familiar vs. unfamiliar) as between-subject factors. Means and standard deviations are summarised in Table 2.

Although there were no significant main effects, the analysis yielded a two-way interaction between the tasks and the order they were presented in, $F(1, 34) = 21.70$, $MSE = 36.22$, $p < .001$, $\eta_G^2 = .07$.[3] For the past planning task, participants recalled more information units about the way they planned their past camping trip if they imagined planning a future camping trip first, $F(1, 34) = 8.74$, $MSE = 36.22$, $p = .006$, $\eta_p^2 = .20$. For the future planning task, participants recalled a similar number of information units irrespective of when they completed the task: first or second.

The three-way interaction between the type of task, task order, and the familiarity of the future planning scenario also was significant, $F(1, 34) = 6.09$, $MSE = 36.22$, $p = .019$, $\eta_G^2 = .02$. Bonferroni

number of information units. For example, one participant simply listed every item of food he would pack. Including them in our analyses would not alter their outcome; on the contrary, it would increase our effect size and therefore gives an erroneous inflated view of our results.

[3]We used generalized eta squared to report effect sizes as this design has a within-subject variable (Bakeman, 2005; Lakens, 2013; Olejnik & Algina, 2003).

Table 2. *Total number of information units in each task as a function of the order of tasks presentation and the familiarity of the future planning scenario*

		Task			
		Past planning		*Future planning*	
Task order	*Future scenario familiarity*	M *(*SD*)*	*95% CI*	M *(*SD*)*	*95% CI*
Past–future	Familiar	31.20 (14.00)	[23.19, 39.01]	29.60 (12.84)	[21.65, 37.55]
	Unfamiliar	33.56 (9.49)	[25.22, 41.89]	43.56 (8.52)	[35.17, 51.94]
	Total	32.33 (11.81)	[26.58, 38.08]	36.58 (12.88)	[30.80, 42.36]
Future–past	Familiar	46.00 (13.34)	[37.66, 54.34]	38.44 (14.21)	[30.06, 46.83]
	Unfamiliar	42.30 (11.77)	[34.39, 50.21]	32.60 (13.01)	[24.65, 40.55]
	Total	44.15 (12.33)	[38.40, 49.90]	35.52 (13.54)	[29.74, 41.30]

CI = confidence interval.

contrasts found a global increase of information units generated between the first task and the second task in all conditions but one. That is, participants invariably gave more details on the second task than on the first, except when they started by remembering how they planned a past camping trip and then imagined planning a camping trip also in Australia.

To summarize, this set of analyses shows that participants recalled more information units if they imagined planning a future event first, regardless of the familiarity of the context of the future event. However, remembering how they planned the past event first did not help participants plan the future event, especially when the context of the future event was familiar.

General use of semantic categories in past and future planning tasks

Second, we investigated the general use of semantic categories in both past and future planning tasks by analysing the presence or absence of at least one information unit in each semantic category of our coding system. For each category, participants received either a score of 1 if they provided at least one information unit coded in this category or 0 if they provided no information unit related to the category, giving them a total maximum of 19 and a total minimum of 0. On average, participants mentioned information units belonging to 12.7 categories for the past planning task (SD = 2.57) and 13.1 categories for the future planning task (SD = 2.81). There were no significant outliers so we used the whole sample for this analysis. Means and standard deviations are summarized in Table 3.

As in the previous set of analysis, we first wanted to investigate the effect of the familiarity of the context on the number of categories used in the future planning task only. Similarly to the analysis run on the quantity of information units, the 2 (task order) × 2 (familiarity of future planning context) univariate ANOVA showed no main effect of the familiarity of the future scenario, $F(1, 36) = 0.01$, $MSE = 6.53$, $p = .947$, and no order effect. Furthermore, we found a similar two-way interaction between task order and familiarity of the context, $F(1, 36) = 8.82$, $MSE = 6.53$, $p = .005$, $\eta_p^2 = .20$. While there was no difference in the number of semantic categories used between the two contexts (Australia and Antarctica) when the future planning task was completed first, participants provided details coded in fewer semantic categories when the future planning tasks was completed second and when the context was familiar (Australia), $F(1, 36) = 9.92$, $MSE = 6.53$, $p = .003$, $\eta_p^2 = .22$.

We also ran another mixed-design ANOVA with type of task (past planning vs. future planning) as a within-subject factor and task order (past–future vs. future–past) and familiarity of future planning context (familiar vs. unfamiliar) as between-subject

Table 3. *Total number of semantic categories used in each task as a function of the order of task presentation and the familiarity of the future planning scenario*

		Task			
		Past planning		Future planning	
Task order	Future scenario familiarity	M (SD)	95% CI	M (SD)	95% CI
Past–future	Familiar	11.20 (2.78)	[9.61, 12.79]	11.20 (3.15)	[9.56, 12.84]
	Unfamiliar	12.60 (1.58)	[11.01, 14.19]	14.80 (2.04)	[13.16, 16.44]
	Total	11.90 (2.31)	[10.78, 13.02]	13.10 (3.18)	[11.84, 14.16]
Future–past	Familiar	13.80 (2.86)	[12.21, 15.39]	13.80 (2.20)	[12.16, 15.44]
	Unfamiliar	13.20 (2.49)	[11.61, 14.76]	12.60 (2.67)	[10.96, 14.24]
	Total	13.50 (2.63)	[12.38, 14.62]	13.20 (2.46)	[12.04, 14.36]

Note: CI = confidence interval.

factors, on the total number of semantic categories used. There were no significant main effects or interactions, which indicates that participants used the same average number of semantic categories in each scenario, regardless of the condition they were in or the task they were completing.

This set of analyses shows that participants used most of the semantic categories in both past and future planning tasks, as predicted by the literature on scripts. Yet, the number of categories used in the future planning task was significantly lower when the context of the event was familiar and when future planning was completed after the past planning task.

Analysis of script similarity across past and future planning tasks

To investigate script similarities across tasks, for each participant we counted how many of our 19 semantic categories were present *in both tasks* (past and future planning), *in the past planning task only*, *in the future planning task only*, and *in neither task* (categories that were never mentioned). For example, if a participant mentioned planning for food in his/her past and future plans (regardless of him/her stating 1 food item or 10 food items), the food category would be placed in the *both tasks* variable. We therefore compiled four values for each participant that represent script similarity (or lack of) between both completed tasks. These values were then averaged across participants to create these new dependent variables. As some assumptions were violated, we ran 2 (task order) × 2 (familiarity of future planning context) factorial ANOVAs with bootstrapping procedures[4] on each of these four dependent variables. Results are shown in Table 4.

There were no significant main effects or interactions when the dependent variables were the number of semantic categories present in both tasks, in the past planning task only, or in the future planning task only. There was, however, a strong two-way interaction for the analysis with *in neither task* as the dependent variable, $F(1, 36) = 9.64$, $MSE = 4.15$, $p = .004$, $\eta_p^2 = .21$. When the scenario was familiar (Australia) for both tasks, not mentioning certain semantic categories during the past planning task completed first made them less likely to be mentioned during the future planning task completed second. In the other three conditions ("past planning then future planning in Antarctica", "future planning in Australia then past planning", "future planning in Antarctica then past planning"), most categories were at least discussed in one of the two tasks, if not in both.

Together, these results show that when participants provided details coded in one category in the first task, they usually provided details coded in that same category in the second task. However, semantic categories not mentioned

[4]Bootstrapping procedures are robust methods that can be used when some assumptions are violated (Field, 2009).

Table 4. *Average presence of semantic categories for each participant in neither task, in both tasks, in the past planning task only, or in the future planning task only, as a function of the order of task presentation and the familiarity of the future planning scenario*

	Task order			
	Past–future		*Future–past*	
	Future scenario familiarity			
Measure	*Familiar* M (SD)	*Unfamiliar* M (SD)	*Familiar* M (SD)	*Unfamiliar* M (SD)
Categories present in *neither* task	5.3 (2.41)**	2 (1.05)	2.4 (1.84)	3.1 (2.51)
Categories present in *both* tasks	8.7 (2.95)	10.4 (1.90)	11 (3.50)	9.9 (2.51)
Categories present only in the *past planning* task	2.5 (1.72)	2.2 (1.40)	2.8 (1.69)	3.3 (1.16)
Categories present only in the *future planning* task	2.5 (1.96)	4.4 (1.84)	2.8 (1.93)	2.7 (1.34)

$^{**}p < .01$.

when recalling past planning were less likely to be discussed when planning a future camping trip in Australia.

Discussion

In the present study, we investigated the quantity of information units as well as the use of semantic scripts in a past and a future planning task, with the future planning task set in either a familiar (Australia) or an unfamiliar (Antarctica) context. First, we investigated potential differences between the two contexts of the future planning task. Similarly to previous studies (Arnold, McDermott, & Szpunar, 2011), participants rated the unfamiliar scenario as harder than the familiar scenario. Yet our results showed no differences between the two conditions in terms of the quantity of information units produced. In spite of the fact that participants had experiences of camping in Australia and had never been to Antarctica, they produced as many information units when imagining their plans for camping in Antarctica as in Australia when they completed the future planning task first. We also found no difference between the two contexts when investigating the number of semantic categories. The inconsistency of our results with de Vito et al. (2012)'s study—who found that familiar events contained more internal details than unfamiliar events—might be because they focused on the simulation of events, whereas we focused on the role of simulation in planning. Therefore, our results could indicate that future planning is not so constrained by familiarity, and that scripts and semantic knowledge could suffice to plan a future event. Our results also support the semantic scaffolding hypothesis, which suggests that depending on the familiarity of the event, one would be more likely to draw upon either on episodic details or on semantic memory (Irish & Piguet, 2013).

Second, we analysed the similarities and interactions across both past and future planning tasks. Our results found interactions between the tasks and the order they were presented in. This order effect can be divided into two separate findings. The first major finding from task interaction can be found in the higher number of information units in the past planning task when completed second than when completed first. It is important to note that familiarity of the future context did not influence our results. This finding was relatively surprising as until now research had only investigated the influence of memory on future thinking and not the opposite. We can therefore propose a tentative account of this effect through the concept of scripts, but further research is needed to investigate the underlying processes at play. Similar to Bartlett's (1932) concept of schemas, scripts represent a general sequence of events and can originate from repeated events, as well as from general semantic knowledge. Because of this, even if they are conventionally considered semantic memory, scripts might have more in common with concepts such as Neisser's (1981) "repisodic memory", Barsalou's (1988) "extended events", or Conway and Pleydell-Pearce's (2000) "general events", which are neither truly semantic nor episodic (Greenberg & Verfaellie, 2010; Martin-Ordas, Atance, & Louw, 2012). They are representative versions of similar events and can support both remembering and future thinking processes. Thus, when asked, as a first task, to imagine how they would plan for a future camping trip, participants could have relied on scripts to help them decide what they needed to plan, as well as on memories of how they planned past camping trips. Subsequently, when asked to recall how they planned a camping trip in the past, these scripts were accessible and facilitated the remembering process. Therefore they recalled more details than participants who did not already have these extensive scripts activated. We also find a similar influence of scripts when participants imagined planning a future camping trip in Antarctica as their second task. Script as well as episodic details could also have facilitated their future plans. However, as they had never camped or even been in Antarctica, on top of the activated scripts, they had to actively think of new details to consider and rely also on semantic knowledge they had about Antarctica.

Yet, we did not find the same influence of scripts when the future planning task was set in Australia and completed second. Compared to the other conditions where there was an increase in the amount of information units produced from the first to the second task, participants imagining how they would plan a future camping trip in Australia as their second task generated no more information units than they did when they remembered how they planned a similar past trip during the first task. The numbers even showed a small but non-significant reduction in the quantity of information units generated between the two tasks. A possible interpretation would be that in this case, participants relied more on episodic memory as a complete relevant plan had just been produced. Consequently when participants imagined how they would plan for a camping trip also in Australia, they might have simply produced a very similar version to what they had just told us but in a future tense, without trying to think of new details or possible changes in the context. If their plans were successful in the past, repeating them in the future could be an efficient approach.

However, we could also find another potential interpretation of this result in the retrieval-induced forgetting phenomenon, where the act of remembering an item can inhibit the retrieval of related items later on (Anderson, Bjork, & Bjork, 1994). It is possible that in this case, remembering the past plan inhibited the search for additional similar details. Nevertheless, we found converging evidence for the first interpretation in our analysis of script similarities across past and future planning tasks. Our results indicated that, in general, if a category was mentioned in one of the tasks, participants also generated information units from that category in the second task. This result shows that similar scripts were used in both tasks. Moreover, the analysis further revealed that if a category was not mentioned in the first task, participants might still generate information units from that category in the second task. This was true of all conditions except when participants had to imagine planning a future event in a familiar context as the second task. In this case, categories not mentioned during the past planning task were also unlikely to be mentioned during the future planning task set in the familiar context. This indicates that participants simply followed the same script as the one they had just mentioned without adding categorically new details to their plan.

In summary, if the simulating subcomponent of the planning process is a type of episodic future thinking, then our study shows that the interaction between past and future thinking goes both ways. On the one hand, our findings suggest that starting by remembering the planning of a past event can influence the capacity to plan a future one in a similar context. On the other hand, starting by planning a future event might activate semantic categories that could later support the remembering process. Hence, future thinking seems to rely on episodic memory—especially when the information has been recently recalled—but is not constrained by it. However, episodic details are not the only components of future thinking; our results also indicate that semantic knowledge and script-knowledge play important roles when imagining and planning future events.

Importantly, our findings also highlight that the order of presentation of past and future thinking tasks matters, as they can influence one another. Future studies should keep in mind this order effect, as we know now that past memories can affect the way we think about similar future events and vice versa. Randomizing the task order might not be enough to control for the effect and might even confound results. Depending on the goal of the study, this order effect could potentially be reduced by running conditions on different days, by avoiding similar events in past and future tasks, or by accounting for it when running statistics. However, future studies should investigate the extent to which past and future interact and the underlying processes, depending on the familiarity of the events, their occurrence in everyday life, and the prevalence of cultural semantic scripts. Finally, research should continue to explore the role of semantic knowledge in the formation of future thoughts and planning as a function of the quantity of related memories available and the need to make the future thought or the future plan as plausible as possible.

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