Prevalence and determinants of direct and generative modes of production of episodic future thoughts in the word cueing paradigm

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Abstract

Recent research suggests that episodic future thoughts can be formed through the same dual mechanisms, direct and generative, as autobiographical memories. However, the prevalence and determinants of the direct production of future event representations remain unclear. Here, we addressed this issue by collecting self-reports of production modes, response times (RTs), and verbal protocols for the production past and future events in the word cueing paradigm. Across three experiments, we found that both past and future events were frequently reported to come directly to mind in response to the cue, and RTs confirmed that events were produced faster for direct than for generative responses. When looking at the determinants of direct responses, we found that most past and future events that were directly produced had already been thought of on a previous occasion, and the frequency of previous thoughts predicted the occurrence of direct access. The direct production of autobiographical thoughts was also more frequent for past and future events that were judged important and emotionally intense. Collectively, these findings provide novel evidence that the direct production of episodic future thoughts is frequent in the word cueing paradigm and often involves the activation of personally significant “memories of the future.”

Keywords: episodic future thinking; autobiographical memory; episodic memory; retrieval processes; goals.

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Much of our actions are guided by the events we anticipate, their envisioned consequences, and our goals and plans in attaining or avoiding imagined states of affairs. Elucidating the cognitive systems and processes that allow us to consider possible futures is, therefore, an important step in understanding human behavior. In the past few years, substantial evidence—from cognitive, neuroimaging, developmental, and patient studies—has accumulated to show that future scenarios are founded on information stored in episodic and semantic memory (for review, see D'Argembeau, 2012; Schacter et al., 2012; Szpunar, 2010). Memory for specific happenings in one's personal past provides an important source of details (e.g., about people, objects, locations, and actions) for imagining events that might lie ahead (Schacter & Addis, 2007; Suddendorf & Corballis, 2007) and semantic knowledge contributes the framework or scaffolding into which episodic details can be integrated (D'Argembeau & Mathy, 2011; Irish, Addis, Hodges, & Piguet, 2012). Despite these recent advances in understanding the sources of information supporting episodic future thinking, the mechanisms underlying the production of future event representations are not fully understood. Here, we examine the prevalence and determinants of two possible modes of production of episodic future thoughts: direct and generative.

Direct and generative retrieval in autobiographical memory

A prominent theoretical account of autobiographical memory contends that memories for past experiences are transitory mental constructions generated from a hierarchically structured knowledge base that includes general knowledge about one's life (lifetime periods and general events) as well as specific episodic details (Conway, 2005, 2009; Conway &

Pleydell-Pearce, 2000). The construction of specific memories from this system can occur through two mechanisms: generative and direct retrieval. Generative retrieval refers to an effortful process involving iterative searches in the knowledge base: cues are first elaborated, then memory is searched and the outputs from memory are evaluated and, if required, these outputs are elaborated further and another search is undertaken (Burgess & Shallice, 1996; Conway & Pleydell-Pearce, 2000). During this process, knowledge access typically proceeds from the abstract to the specific, with general autobiographical knowledge (i.e., a lifetime period and/or an associated general event) being accessed first and then used to access episodic details (Haque & Conway, 2001). Direct retrieval, on the other hand, refers to an automatic and effortless associative process whereby internal or external cues activate episodic details such that a coherent event representation is formed without the need of elaborating retrieval cues to search memory. The main difference between the two modes of retrieval is that the search process is modulated by control processes in generative retrieval but not, or not so extensively, in direct retrieval (Conway & Pleydell-Pearce, 2000).

While it has been generally assumed that generative retrieval is the dominant mode of formation of autobiographical memories (Conway & Pleydell-Pearce, 2000; Haque & Conway, 2001), recent findings suggest that direct retrieval is more frequent than previously thought. First, there is evidence that involuntary memories—memories that come to mind with no preceding attempt at retrieval (Berntsen, 1996)—are common in everyday life, perhaps even more frequent than effortfully generated memories (Rasmussen & Berntsen, 2011). Although the concepts of involuntary retrieval and direct access are not equivalent (i.e., direct access can potentially occur whether or not memories are retrieved voluntarily), such studies nevertheless suggest that memories are frequently accessed with no search effort. Second, a recent study by Uzer, Lee, and Brown (2012) has shown that direct retrieval also

occurs frequently when people voluntarily recall memories in experimental tasks such as the Crovitz word cueing paradigm—one of the most commonly used method to elicit autobiographical memories. In a first experiment, participants were cued with objects (e.g., *bag*) or emotions (e.g., *happy*) words and were instructed to say aloud everything that came to mind until they had a specific past event in mind. Once a suitable memory was recalled, participants were asked to report whether the memory was retrieved directly and without apparent effort (i.e., the memory was immediately triggered by the cue word) or whether they had to make a conscious effort by searching memory and using other information in order to recall a suitable memory. The verbal protocols and self-reports of retrieval strategy converged to show that the direct retrieval of memories was more frequent than generative retrieval (the overall prevalence of self-reported direct retrieval was 60%). Furthermore, response times (RTs) indicated, as predicted, that direct retrieval was much faster than generative retrieval. The authors replicated these results in a second experiment in which participants performed the same cueing task silently and alone without providing verbal protocols. Finally, converging results were obtained in a third experiment in which direct retrieval was assessed in terms of information use during retrieval (i.e., whether or not participants used information about their life to help them recall the memory). Taken together, these studies suggest that direct retrieval in autobiographical memory is at least as common as generative retrieval, even in experimental cueing paradigms that were previously thought to rely mainly on generative processes.

Modes of production of episodic future thoughts

According to the constructive episodic simulation hypothesis (Schacter & Addis, 2007; Schacter, Addis, & Buckner, 2008), episodic future thoughts are formed by extracting

and flexibly recombining details from past experiences into coherent representations of realistic, yet novel, future events. This constructive process is presumably effortful and relies on executive control processes to search for, monitor, and combine relevant memory elements. The contribution of control processes has indeed been evidenced in several studies that examined the production of episodic future thoughts in the word cueing paradigm. In particular, it has been found that individual differences in executive resources and working memory capacity correlate with the ability to imagine specific future events (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010; Hill & Emery, 2013), and that the experimental depletion of executive resources by means of a concurrent task results in increased RTs and error rates, at least when future thoughts are cued with low imageability words (Anderson, Dewhurst, & Nash, 2012). Furthermore, there is evidence that the imagination of future events in response to word cues often involves a protracted generative process in which general information about one's life is retrieved and used for constructing a specific episode (D'Argembeau & Mathy, 2011).

Other evidence suggests, however, that episodic future thoughts are sometimes produced without the intervention of controlled processes. Berntsen and colleagues (Berntsen & Jacobsen, 2008; Finnbogadottir & Berntsen, 2013) have shown that episodic future thoughts can occur involuntarily (i.e., with no conscious attempt to generate these representations), suggesting that the production of future event representations does not necessarily require search effort. Other recent findings suggest that voluntary prospection can also entail the direct production of episodic future thoughts. Anderson, Dewhurst, and Nash (2012) found that participants were faster in imagining specific future events when they were cued with high imageability words (e.g., *butterfly*) compared to low imageability words (e.g., *attitude*). Insofar as decreases in the time needed to produce a specific event to high versus

low imageability words may reflect greater reliance on direct retrieval (Williams, Healy, & Ellis, 1999), these findings suggest that episodic future thoughts may sometimes be produced directly. This evidence is somewhat indirect, however, because the modes of formation of future event representations were inferred from differences in RTs and were not explicitly assessed. As noted by Uzer et al. (2012), differences in RTs could either reflect the existence of two distinct processes (direct vs. generative) or could be due to variations in the difficulty of a single generative process. More straightforward evidence for the direct production of episodic future thoughts during voluntary prospection comes from a study that used a think-aloud procedure to determine the types of information accessed when future event representations were formed. D'Argembeau and Mathy (2011) asked participants to report everything that came to their mind when they attempted to imagine specific future events in response to cue words. They found that on most trials participants reported general information about their life before a specific event was constructed, thus showing that they relied on generative processes. Interestingly, however, episodic future thoughts were sometimes produced rapidly (as indicated by RTs data) and the verbal protocols suggested that the event representations came directly to mind (i.e., without using general information about one's life for constructing the event).

The present research

Overall, the available evidence suggests that episodic future thoughts can be produced through the same dual mechanisms, direct and generative, as autobiographical memories. The prevalence of the direct formation of future event representations during voluntary prospection remains unclear, however, because the modes of production of future thoughts have not been directly assessed. Different possibilities can be considered. On the one hand,

given the necessity to flexibly recombine appropriate memorial information to form coherent future event representations (Schacter & Addis, 2007), one would expect that generative processes would be the dominant mode of episodic future thinking. On the other hand, considering the adaptive value of prospective thought (Boyer, 2008; Schacter, 2012), it is conceivable that mechanisms allowing rapid anticipation and planning of future contingencies based on memory had been designed by natural selection (Klein, 2013). Furthermore, some imagined future events may be encoded in memory—as "memories of the future" (Ingvar, 1985; Szpunar, Addis, McLelland, & Schacter, 2013)—such that they could later be directly accessed in response to relevant cues. In everyday life, people indeed frequently and repeatedly think about some future events (D'Argembeau, Renaud, & Van der Linden, 2011; Watkins, 2008), which might lead to readily accessible memories of the future.

To shed light on these possibilities, we investigated the prevalence and determinants of the direct production of episodic future thoughts, using an adaptation of the strategy reports created by Uzer et al. (2012) to gauge the frequency of directly retrieved memories in the word cueing paradigm. In Experiment 1, we assessed the frequency of the direct mode of production of past and future events and further investigated whether certain characteristics of memories and future thoughts (such as previous recall/imagination, emotional value, and personal importance) predicted direct access. Experiment 2 was then conducted to ensure that directly accessed future thoughts indeed referred to anticipated future events and did not simply consist in directly retrieved past events that would be recasted as future events. Finally, in Experiment 3, we sought to delve deeper into the nature of the direct mode of production of memories and future thoughts by distinguishing between two dimensions of direct access: search effort and information use.

Experiment 1

The aim of Experiment 1 was threefold. First, we sought to assess the frequency of the direct production of episodic future thoughts in the word cueing paradigm and to compare it to the frequency of directly retrieved memories (Uzer et al., 2012). Second, we investigated whether the frequency of directly produced memories and future thoughts is modulated by the temporal distance of events. Considering that the quantity and quality of memories and future thoughts decrease with increasing temporal distance (D'Argembeau & Van der Linden, 2004; Spreng & Levine, 2006), we expected that the direct production of event representations would be less frequent for the distant past and future than for closer time periods. Third, we aimed to explore possible determinants of the direct mode of production of autobiographical representations. Frequently retrieved memories tend to more accessible than less frequently retrieved memories (Thompson, Skowronski, Larsen, & Betz, 1996) and, therefore, one would expect that direct retrieval would be more common for the former kind of memories. In a similar vein, as suggested above, future events that are frequently thoughts about might lead to readily accessible memories of the future that could be directly accessed in response to relevant cues. Therefore, we predicted that the frequency of previous thoughts about an event would predict the occurrence of direct access, both for memories and future thoughts. Finally, in addition to frequency of thoughts, we also explored the possible impact of other dimensions that have been shown to influence the accessibility of memories and future thoughts, such as emotional value and personal importance (e.g., D'Argembeau & Van der Linden, 2004; Newby-Clark & Ross, 2003).

Method

Participants. Thirty-two undergraduate students (21 females and 11 males) aged between 18 and 27 years (M = 21.5 years, SD = 2.5 years) participated in this study. They all provided written informed consent for their participation and were tested individually.

Materials and procedure. Participants were asked to recall specific events that happened in their personal past and to imagine specific events that might reasonably happen to them in the future, in response to a series of cue words. Twenty cue words referring to common places, objects, persons, and feelings (e.g., *friend, school, garden, restaurant, book, love*) were selected from previous studies of autobiographical memory and future thinking (Conway, Pleydell-Pearce, & Whitecross, 2001; D'Argembeau & Mathy, 2011). These words were divided into four lists of five cues that were matched for word length (number of letters), imageability, and frequency of use (Desrochers & Bergeron, 2000). These four lists served as stimuli for the four conditions (near past, distant past, near future, distant future) and the assignment of lists to conditions was counterbalanced across participants. Within each condition, the five cue words were presented in random order.

The tasks were programmed and presented using E-Prime 2.0 software (Psychology Software Tools, Inc.). Depending on the condition, an instruction slide first informed participants that their task was to recall events that happened during the last week (near past condition), to recall events that happened more than one year ago (distant past condition), to imagine events that might happen during the next week (near future condition) or to imagine events that might happen in more than a year from now (distant future condition). It was emphasized that the produced events should be specific (i.e., unique events taking place in a specific place at a specific time and lasting a few minutes or hours but not more than a day) and refer to personal experiences; for future events, it was also mentioned that the events should be plausible (i.e., something that might reasonably happen).

Following the instruction slide, the five trials of the corresponding condition were presented. Each trial started with the presentation of the signal “READY” during 1.5 s, followed by an empty screen for 1 s. Then, a cue word was presented, and participants were instructed to retrieve or imagine a specific event, as quickly as possible, in response to the cue. As soon as an appropriate event came to mind, they were instructed to press the spacebar (which recorded RT) and to briefly describe the recalled or imagined event on a sheet of paper (if no appropriate event came to mind within 90 s of the word cue being presented, the computer terminated the trial automatically, and the participant was requested to initiate a new trial). Then, participants were asked to judge whether the event came to their mind directly or whether some active search was necessary. Definitions of direct and generative access (which were adapted from Uzer et al., 2012) were provided before the experiment: participants were told that sometimes memories or imagined future events can automatically come to mind (i.e., with little or no effort), whereas at other times memories or imagined future events have to be actively searched. It was explained that during the task some memories or imagined future events might be immediately triggered by the cue word, but sometimes the participant would need to actively search and reflect in order to find a suitable event. For each trial, participants were instructed to press the key *1* if the event came directly to mind or the key *2* if the production of the event required an active search effort. Finally, participants were invited to write a brief title for the event, which was used to identify events in the next phase of the experiment.

Immediately after the five trials of a given condition, participants were instructed to come back to each of the five events they had recalled or imagined and, for each event, they estimated its temporal distance (in hours, days, weeks, months and years), they indicated whether they already thought about this event on a previous occasion (by answering “yes” or

"no"; if they responded "yes", they were also asked to rate the extent to which they previously thought about this event, from 1 = very rarely, to 7 = very often), and they rated the personal importance of the event (from 1= not at all important, to 7 = extremely important) and its affective valence (- 3 = very negative, 0 = neutral, +3 = very positive). For future events, participants also estimated the probability that the imagined event would actually happen in the future (1 = extremely low, 7 = extremely high). After making these judgments for each of the five events, participants proceeded to the next condition. The order of presentation of the four conditions was counterbalanced across participants.

Before starting the experimental trials, participants received two practice trials (with different cue words) that were then discussed with the experimenter to ensure that participants correctly understood all instructions.

Results

The reported estimations of temporal distance confirmed that participants produced events falling in the required categories; the mean temporal distance was, in days, 1550 in the distant past condition, 1071 in the distant future condition, 4 in the recent past condition, and 5 in the near future condition.

The mean proportion of events that directly came to mind in response to the cues (as estimated by participants) is shown on Figure 1, as a function of temporal orientation (past vs. future) and temporal distance (near vs. distant). As can be seen, the majority of events were produced directly, not only for past events but also for future events. A 2 (temporal orientation) x 2 (temporal distance) repeated-measures analysis of variance (ANOVA) showed a significant effect of temporal distance, $F(1, 31) = 5.08$, $p = 0.03$, $\eta_p^2 = 0.14$,

indicating that the direct mode of production was more frequent when recalling or imagining events that refer to a temporally close time period. There was no significant effect of temporal orientation, $F(1, 31) = 2.59$, $p = 0.12$, $\eta_p^2 = 0.08$, and no interaction between temporal orientation and temporal distance, $F(1, 31) = 0.38$, $p = 0.54$, $\eta_p^2 = 0.01$.

Next, we examined whether RTs differed as a function of the mode of production of events. For each participant, we computed median RTs for direct and generative responses in the past and future event conditions (four participants were excluded from this analysis because they did not provide any generative response in the past or future event conditions). The means across participants are shown in Figure 2, as a function of the mode of production of events and their temporal orientation. A 2 (mode) x 2 (temporal orientation) ANOVA yielded a significant effect of mode, $F(1, 27) = 49.67$, $p < 0.001$, $\eta_p^2 = 0.65$, showing that RTs were faster for direct than generative responses. There was no significant effect of temporal orientation, $F(1, 27) = 2.72$, $p = 0.11$, $\eta_p^2 = 0.09$, but the interaction between temporal orientation and mode was significant, $F(1, 27) = 6.03$, $p = 0.02$, $\eta_p^2 = 0.18$. Follow-up *t*-contrasts showed that there was no significant difference in RTs between past and future events when the events were produced directly, $t(27) = 0.95$, $p = 0.35$, $d = 0.18$, but future events were produced faster than past events in the generative mode, $t(27) = 2.21$, $p = 0.04$, $d = 0.42$.

This latter finding was somewhat unexpected and we further investigated whether these faster RTs could be related to the extent to which participants had previously thought about the reported events.[1] We indeed found that, for events reported in the generative mode, the proportion of events that had been thought of previously was significantly higher for future events than for past events, $t(27) = 2.05$, $p = 0.049$, $d = 0.39$, such that the above-

[1] We thank an anonymous reviewer for calling our attention to this possibility.

mentioned difference in RTs could in part be due to differences in previous thoughts about the events. Therefore, we examined whether RTs in the generative mode would differ between past and future events that had not been thought of previously. When looking specifically at this subset of events, there was no significant difference in RTs between past and future events, $t(18) = 1.24$, $p = 0.23$, $d = 0.29$, although numerically the difference was still in the same direction (means of median RTs were 12573 ms, *SEM* = 1720 ms, and 9938 ms, *SEM* = 1231 ms, for past and future events, respectively). This analysis should be taken with caution, however, because only 19 participants could be included (i.e., participants who reported at least one event that had not been thought of previously, both in the past and in the future conditions) and many of the data points (12 out of 38) were computed on the basis of only one event (e.g., because the participant reported only one past event that had not been thought of previously).

An important goal of this study was to determine whether the direct mode of production of events depended on having previously thought about these events, as well as on their personal importance and affective value. To examine these questions, we conducted a series of logistic regressions to investigate the effect of each variable on the odds of the direct mode of production of events. To account for the hierarchical structure of the data (i.e., events are nested within participants and are thus not independent), we used multilevel modeling (Goldstein, 2011) with events as level 1 units and participants as level 2 units. These analyses were performed using MLwiN and second-order penalized quasi-likelihood as estimation method (Rasbash, Charlton, Browne, Healy, & Cameron, 2011).

For past events, we found that the percentage of direct responses was significantly higher for events that had been thought of previously (67%) than for events that had not been thought of previously (50%; coefficient = 0.73, *SE* = 0.25, $Z = 2.92$, $p = 0.003$). A similar

trend was observed for future events, with the percentage of direct responses being respectively 71% and 60% for events that had been thought of and events that had not been thought of previously (coefficient = 0.52, *SE* = 0.27, *Z* = 1.93, *p* = 0.054). Furthermore, among past and future events that had been thought of previously, the odds of direct response increased with the frequency of previous thoughts about the events (past events: coefficient = 0.22, *SE* = 0.11, *Z* = 2.00, *p* = 0.04; future events: coefficient = 0.34, *SE* = 0.10, *Z* = 3.45, *p* < 0.001). Thus, for both the past and future, having previously thought about an event seems an important determinant of direct production. In fact, the majority of events that were produced directly had been thought of on a previous occasion, with no significant difference between past and future events in this respect (69% of past events and 73% of future events that were produced directly had been thought of on a previous occasion; coefficient = 0.18, *SE* = 0.23, *Z* = 0.78, *p* = 0.43).

For both past and future events, we also found that the odds of direct response increased with the importance attributed to the events (past events: coefficient = 0.41, *SE* = 0.08, *Z* = 5.13, *p* < 0.001; future events: coefficient = 0.20, *SE* = 0.08, *Z* = 2.40, *p* = 0.02). With regard to affective valence, an initial inspection of the percentage of direct responses across levels of the 7-point rating scale showed a V-shaped relation between the ratings and the frequency of direct responses, suggesting that the occurrence of direct responses increased with the affective intensity of events. Therefore, we created a new variable reflecting the affective intensity of events by taking the absolute value of affective ratings and investigated whether this variable predicted the odds of direct response. For past events, the odds of direct response significantly increased with the affective intensity of events (coefficient = 0.42, *SE* = 0.12, *Z* = 3.50, *p* < 0.001); a similar trend was observed for future events, although the effect failed to reach statistical significance (coefficient = 0.22, *SE*= 0.12, *Z* = 1.83, *p* = 0.066).

Finally, we found that for future events the odds of direct response significantly increased with the perceived probability that the imagined events would actually happen in the future (coefficient = 0.40, *SE* = 0.10, *Z* = 4.08, $p < 0.001$).

All the effects on the odds of direct response reported above remained unchanged when temporal distance was entered in the model (coded as a categorical variable: close vs. distant), and there was no interaction between the variable of interest and temporal distance, with the following exception: for future events, a significant interaction term indicated that the effect of importance on the odds of direct response was more pronounced for the distant future than for the near future (coefficient = 0.40, *SE* = 0.17, *Z* = 2.35, $p = 0.02$).

Discussion

The results of Experiment 1 replicated the findings of Uzer et al. (2012) that directly retrieved memories are common in the cue-word paradigm, with the percentage of directly retrieved memories being comparable between the two studies (i.e., around 60%). Also consistent with the results of Uzer et al., we found that directly retrieved memories were formed much faster than generated memories. Our main aim was then to investigate whether the direct production of episodic future thoughts is also frequent in the same word cueing conditions. We found that the direct production of event representations was as frequent and as fast for episodic future thoughts as it was for memories. This finding provides novel and more straightforward evidence that future event representations are often produced immediately and with no apparent search effort in the word cueing task.

Another important contribution of Experiment 1 is to shed light on the determinants of the direct mode of production of events. As expected, we found that most events that were

produced directly had already been thought of on previous occasions. This was not only the case for past events but also for future events, suggesting that most episodic future thoughts that were produced directly were memories of the future rather than newly imagined future events. Besides previous thoughts, our results also showed that the frequency of direct access increased as a function of the personal significance of events (as reflected by ratings of importance and emotional value).

While the direct production of autobiographical representations was common whatever the contemplated time period, a significant effect of temporal distance was observed, showing that direct access was more frequent for the recent past and near future than for the distant past and future. This suggests that memories and future thoughts are more readily accessible when they are closely related to the present. Such highly accessible memories for recent past experiences and anticipated experiences might function to keep us tightly connected to our current goals and plans (Conway, 2009).

An unexpected finding was that, when event representations were not produced directly, people took more time for generating memories than future thoughts. This seems in contradiction with some previous studies that used a similar cueing paradigm and found that RTs either did not differ between past and future events or were faster for past than for future events (e.g., Anderson et al., 2012). However, these previous studies did not assess the modes of production of event representations and they likely involved a mix of direct and generative processes, which renders a direct comparison with our data difficult. One possible explanation for the present finding is that this difference in RTs was, at least in part, due to previous thoughts about the events: indeed, the proportion of events produced in the generative mode that had been thought of previously was significantly higher for future events than for past events and, when only the subset of events that had not been thought of previously were

analyzed, the difference between past and future events in RTs was no longer statistically significant (although numerically, the difference was still in the same direction). Another, not necessarily mutually exclusive, explanation would capitalize on the idea that remembering the past is more constrained by reality concerns than is imagining the future (Van Boven, Kane, & McGraw, 2009): in the former case, one has to produce an event that actually happened (or at least that one believes actually happened), thus adding a search parameter that could slow down the generative process.

Experiment 2

The results of Experiment 1 show that the direct production of episodic future thoughts is common in the word cueing paradigm and is predicted by the frequency of previous thoughts about the events. In Experiment 2, we aimed to replicate these findings while excluding several contaminating factors that could have contributed to the high frequency of direct responses in Experiment 1. First, in Experiment 1, the specificity of future event representations could not be meaningfully checked (because participants only provided a brief title for each event they imagined) and it could thus be the case that some event representations that were directly formed were in fact not specific. Therefore, in Experiment 2, we asked participants to describe imagined events in more detail, such that we could estimate the prevalence of direct access for trials involving the imagination of a specific event. Second, it could be that some events participants reported as directly produced were in fact not truly anticipated experiences: another possibility would be that the cue word directly triggered the memory of a past event which would then be simply recasted as a future event. To investigate this “recasting hypothesis” (Addis, Pan, Vu, Laiser, & Schacter, 2009; Gamboz, Brandimonte, & De Vito, 2010), we asked participants to evaluate the similarity of

each imagined future event to past experiences and to indicate whether they used past events to imagine this future event.

Method

Participants. Twenty undergraduate students (10 females and 10 males) aged between 18 and 30 years (M = 21.3 years, SD = 2.8 years) participated in this study. A power analysis using the MLPowSim Software Package (Browne, Golalizadeh, & Parker, 2009) indicated that this sample size at level 2 (participants) and a sample size of 15 at level 1 (events; see below) yielded an estimated power of above 0.95 to detect a significant effect (with an alpha of 0.05, two-tailed) of the size observed in Experiment 1 for the effect of frequency of previous thoughts on the odds of direct responses for future events. All participants provided written informed consent and were tested individually.

Materials and procedure. The procedure and materials were similar as in Experiment 1, with the following modifications. First, only cue words referring to objects (e.g., *book*, *bottle*) or locations (e.g., *hotel*, *restaurant*) were used in this experiment; feeling words were removed because previous research suggests that they may involve distinct retrieval processes in the word cueing task (e.g., Conway et al., 2001). Second, participants were only instructed to imagine future events (i.e., there was no past event condition) and the number of trials was increased to 15. Third, there was no constraint regarding the temporal distance of imagined events. Fourth, after each event had been produced, participants were invited to describe the event on a sheet of paper, and they were asked to describe it with sufficient details so that

someone could understand that it referred to a specific event. We used these instructions so that we could later check that each reported event was specific.

Immediately after the 15 trials, participants were instructed to come back to each future event they imagined and, as in Experiment 1, they were invited to date each event, to indicate whether they previously thought about this event (by answering “yes” or “no”; if they responded “yes”, they were also asked to rate the extent to which they previously thought about this event, from 1 = very rarely, to 7 = very often), and to rate its personal importance (from 1= not at all important, to 7 = extremely important). Furthermore, in the present experiment, participants were also asked to rate the similarity of the imagined event to previously experienced events (from 1 = the exact same event was experienced previously, to 5 = the event is completely novel; Addis, Musicaro, Pan, & Schacter, 2010) and to indicate whether they thought about one or more past event(s) during the imagination of the future event (by answering "yes" or "no"; if they responded “yes”, they were also asked to indicate if they used this or these event(s) for imagining the future event, by answering “yes or “no”). Finally, participants were asked to determine whether the imagined future event was linked to one or more future event(s) produced on a previous trial (by answering "yes" or "no").

Scoring. All events were scored as specific or non-specific by the first author. Events were considered specific if they referred to events happening on a particular occasion (i.e., in a specific place at a specific time) and lasting no longer than a day (Williams et al., 1996). A random selection of 20% of events was also independently scored by the second author. The coefficient of raw agreement *ra* = 0.95; we did not assess the degree of rater agreement using Cohen’s k because of the marginal dependency of k for extreme marginal distributions (see von Eye & von Eye, 2008; in the present case, the marginal distributions were not uniform, with the cell frequency corresponding to a rating of non-specificity by both raters being 0).

Results

In total, the 20 participants reported 300 future events. However, 17 of these events (from 12 participants) did not refer to a specific happening; these events were excluded from the analyses, thus leaving 283 specific future events. As in Experiment 1, participants reported that the majority of future events they imagined came directly to mind (mean proportion = 0.63, *SEM* = 0.03), and a paired sample *t*-test showed that RTs were significantly faster for direct than generative responses (means of median RTs were 4943 ms, *SEM* = 571 ms, and 17352 ms, *SEM* = 1912 ms, for direct and generative responses, respectively), $t(19) = 8.19$, $p < 0.001$, $d = 1.83$.

In line with Experiment 1, we found that the direct mode of production of future events depended on having previously thought about these events: the percentage of direct responses was significantly higher for events that had been thought of previously (71%) than for events that had not been thought of previously (41%; coefficient = 1.34, *SE* = 0.29, $Z = 4.62$, $p < 0.001$); among future events that had been thought of previously, the odds of direct response increased with the frequency of previous thoughts about the events (coefficient = 0.41, *SE* = 0.15, $Z = 2.73$, $p = 0.006$). As in Experiment 1, the majority of future events that were accessed directly (84%) had been thought of on a previous occasion. We also replicated the finding of Experiment 1 that the odds of direct response increased with the importance attributed to the events (coefficient = 0.27, *SE* = 0.08, $Z = 3.23$, $p = 0.001$).

Next, we investigated whether the direct mode production of future events could be explained by the recasting hypothesis (i.e., participants may directly retrieve a past event and then simply recast it as a future event). As a first test of this hypothesis, we examined whether

future events that were produced directly were more similar to previously experienced events than future events that were produced using generative processes. We found that similarity with past experiences did not significantly predict the odds of direct response (coefficient = -0.08, *SE* = 0.08, *Z* = 1.06, *p* = 0.29). Furthermore, reports of having thought about one or more past event(s) during the imagination process were not significantly related to the production of direct responses (coefficient = -0.34, *SE* = 0.25, *Z* = 1.33, *p* = 0.18). Finally, reports of having used one or more past event(s) for imagining the future event were also not significantly related to the production of direct responses (coefficient = 0.44, *SE* = 0.40, *Z* = 1.10, *p* = 0.27).

Discussion

The results of Experiment 2 replicated the findings of Experiment 1 that the direct production of episodic future thoughts is common and fast, while ensuring that the future events that were directly produced were specific and did not simply consist in remembered past events recasted as future events. In line with Experiment 1, we also found that having previously thought about events was a significant predictor of direct access and that the large majority of future events that were directly produced had been thought of on at least one previous occasion. Finally, the personal importance of events was also a significant predictor of direct access, again replicating the results of Experiment 1.

Experiment 3

The results of Experiments 1 and 2 converged to show that when they attempted to produce future events in response to cue words, participants frequently reported that a future

event representation was directly triggered by the cue. In Experiment 3, we sought to delve deeper into the nature of the direct formation of episodic future thoughts by distinguishing between two dimensions that could characterize direct responses: search effort and information use (Uzer et al., 2012). Experiments 1 and 2 characterized the distinction between direct and generative responses in terms of search effort: directly produced memories and future thoughts were defined as being formed with no search effort, whereas generated memories and future thoughts were defined as involving an active search process. Another important feature of generative retrieval is the use of general information about one's life (e.g., people we know, activities we engage in, or places we frequent) that can serve as cues for retrieving a specific event (Conway & Pleydell-Pearce, 2000).

Using this definition of generative retrieval in terms of information use during retrieval, Uzer et al. (2012, Experiment 3) found that direct responses were still common, occurring in around 50% of trials. It remains unknown whether this is also the case for episodic future thoughts. In fact, a previous study that used a think-aloud method to assess the kinds of information that were accessed when producing episodic future thoughts found that people most often accessed general information about their life before a specific event was produced (D'Argembeau & Mathy, 2011). It thus remains possible that the production of episodic future thoughts is frequently direct in the sense that it requires no or little search effort (as shown by Experiments 1 and 2), but may still involve the activation of general information about one's life (as shown by D'Argembeau & Mathy, 2011). For instance, a cue could automatically (i.e., with no search effort) trigger knowledge about a person or location we know, which then could automatically trigger the representation of an associated future event. To investigate this possibility in Experiment 3, we used two different questions to assess direct production not only in terms of search effort, but also in terms of the type of information accessed. In addition, we used a think-aloud method, as in D'Argembeau and

Mathy (2011) and Uzer et al. (2012), to independently assess the activation of general information during the production of events.

Method

Participants. Twenty undergraduate students (11 females and 9 males) aged between 18 and 29 years (M = 23 years, SD = 2.64 years) participated in this study. In addition to determining the proportion of direct responses as defined by search effort and information use, we also sought to investigate whether RTs differed as a function of these two dimensions of event production. A power analysis using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) indicated that a sample size of 20 participants yielded a power of above 0.95 to detect a significant effect (with an alpha of 0.05, two-tailed) of the size observed in Experiment 1 for the influence of the mode of production of events on RTs. All participants provided written informed consent and were tested individually.

Materials and procedure. Twenty cue words referring to common objects and locations were divided into two lists of ten cues that were matched for word length (number of letters), imageability, and frequency of use (Desrochers & Bergeron, 2000). Participants were instructed to retrieve 10 past events and to imagine 10 future events in response to these cues, with no constraint in terms of temporal distance. While recalling or imagining an event, participants were instructed to say aloud everything that came into their mind from the time they read the cue word to the time they had a specific event in mind. They were asked to report every thought or image they experienced, even if it had apparently nothing to do with the cue word. A digital audio recorder was used to record all vocalizations during this phase. As soon as an appropriate event came to mind, participants were instructed to press the spacebar, which recorded RT. Contrary to Experiments 1 and 2, we did not impose a time

limit for producing an event because we expected that the recall or imagination process would be slowed down by the think-aloud procedure (Fox, Ericsson, & Best, 2011).

We sought to distinguish two dimensions that may characterize the direct mode of production of autobiographical events: the type of information accessed vs. the effort deployed for producing an event. These two dimensions were assessed using two different questions. Once they pressed the space bar, participants were first asked to assess whether the event came immediately to mind following the presentation of the cue word or whether some general information about their lives came to their mind before they accessed a specific event. Before the experiment, it was explained that in some cases, a specific event can directly come to mind following the presentation of a cue, while in other cases, a specific event may not come immediately to mind and other general information about one's life such as information about an extended period of life (e.g., when I was child) or event categories (e.g., football games) are activated before a specific event is produced. Participants were instructed to press either the *1* key to indicate that a specific event immediately came to mind or the *2* key to indicate that some general information about their lives came to mind before they accessed a specific event. Next, participants were asked to evaluate whether or not the retrieval of the past event or the imagination of the future event required search effort. Before the experiment, it was explained that in some cases, a memory or an imagined event can come to mind automatically, effortlessly, while in other cases, an active search effort is required. Participants were instructed to press either the *1* key to indicate that the event was retrieved or imagined with no search effort, or the *2* key to indicate that the event was retrieved or imagined after an active search effort. Before starting the experiment, the experimenter made sure that the two dimensions were correctly understood and it was further specified that they represent potentially orthogonal dimensions (e.g., an event could be imagined using some

general information about one's life, yet without the need to engage in an active search to access such information).

Scoring. Event specificity was scored using the same method as in Experiment 2. The coefficient of raw agreement *ra* = 0.94; again we did use Cohen's k to express the degree of rater agreement because the marginal distributions were not uniform (von Eye & von Eye, 2008).

Results

In total, the 20 participants reported 200 past events and 200 future events. However, 8 past events and 15 future events were not specific. These non-specific events were discarded and thus the reported analyses were based on 192 past events and 185 future events. Although the two dimensions used to define direct access (i.e., search effort and information use) were related, they were not entirely equivalent (26% of events were classified as direct for one dimension and non-direct for the other dimension); thus we analyzed each dimension separately.

First, we investigated the frequency of direct access as defined by search effort. The mean proportion of events that were produced with no apparent search effort is shown in Figure 3a, as a function of temporal orientation (past vs. future). In line with Experiments 1 and 2, the majority of events were produced without search effort, and there was no significant differences between past and future events in this respect, $t(19) = 0.90$, $p = .38$, $d = 0.20$. Next, we examined the frequency of direct access as defined by information use. The mean proportion of self-reports of events that immediately came to mind in response to the cue (i.e., without accessing more general information first) is shown on Figure 3b, as a

function of temporal orientation. As can be seen, participants judged that the majority of events came immediately to mind, not only for past events but also for future events; a paired sample *t*-test showed no significant difference between past and future events in terms of immediacy of access, $t(19) = 1.04$, $p = .31$, $d = 0.23$.

We also examined whether the verbal protocols obtained while participants produced the events were consistent with their answers to the information use question. The first author listened to each verbal report and judged whether or not some general information was reported before a specific event was described, while blind to how participants had answered the information use question. We then compared the degree of concordance between the coder's judgments and the participants' answers to the information use question. The strength of agreement was good (k = .74, 95% CI: .67-.81), thus providing support for the reliability of participants' judgments of information use.

Next, we examined whether RTs differed as a function of the two dimensions of event production that were investigated here. First, we computed, for each participant, the median RT for past and future events, as a function of whether or not the production of the event required search effort. Means across participants are shown in Figure 4a. A 2 (search effort) X 2 (temporal orientation) ANOVA revealed a main effect of search effort, $F(1, 19) = 23.87$, $p < 0.001$, $\eta_p^2 = 0.56$, indicating that participants took on average more time to produce a specific event when it required a search effort than when it required no search effort. There was no main effect of temporal orientation, $F(1, 19) = 0.08$, $p = 0.78$, $\eta_p^2 = 0.004$, but there was a significant interaction between temporal orientation and search effort, $F(1, 19) = 5.14$, $p = 0.04$, $\eta_p^2 = 0.21$. This interaction indicated that RTs tended to be faster for past events than for future events when the events were produced with no search effort, $t(19) = -1.97$, $p = 0.06$,

d = 0.44, whereas the difference tended to be in the opposite direction when events were produced with search effort, $t(19) = 1.81$, $p = 0.09$, $d = 0.40$.

Finally, we computed, for each participant, the median RT for past and future events, as a function of whether or not the event immediately came to mind. Four participants were excluded from this analysis because one cell was empty (e.g., they did not produce any future event without accessing more general information first). Means across participants are shown in Figure 4b. A 2 (mode of access) x 2 (temporal orientation) ANOVA showed a significant main effect of mode, $F(1, 15) = 34.56$, $p < 0.001$, $\eta_p^2 = 0.69$, showing that RTs were faster when the events came immediately to mind. There was no significant effect of temporal orientation $F(1, 15) = 0.56$, $p = 0.46$, $\eta_p^2 = 0.03$, and no interaction between temporal orientation and mode, $F(1, 15) = 0.87$, $p = 0.36$, $\eta_p^2 = 0.05$.

Discussion

In Experiment 3, we sought to delve deeper into the nature of the direct production of memories and future thoughts by distinguishing between two dimensions: search effort and information use. We found that participants not only reported that memories and future thoughts were frequently produced with no search effort (in line with Experiments 1 and 2), but also that they came immediately to mind (i.e., without accessing more general information first). Moreover, for both dimensions characterizing direct production, we found that RTs were faster for direct than for generative responses. We also asked participants to report everything that went into their minds while producing the events and the analysis of their verbal protocols showed that the information described was in good agreement with participants' own judgments of information use.

In the present experiment, the percentage of episodic future thoughts that were produced without accessing general information first (57%) was much higher than the percentage we observed in a previous study (16%) in which direct and generative modes of formation were assessed using a think-aloud method (D'Argembeau & Mathy, 2011, Study 1). A key difference between the two studies is that D'Argembeau and Mathy required participants to imagine novel events (i.e., events that had not been previously experienced or thought of), whereas in the current experiment the novelty of events was left unspecified. As shown by the results of Experiments 1 and 2, the large majority of future events that were directly produced in the current paradigm have already been thought of on at least one previous occasion (and thus were not novel), which likely explains why the frequency of direct access is substantially higher than in D'Argembeau and Mathy (this point is discussed further in the General Discussion).

General Discussion

The present research aimed to unravel the modes of production of episodic future thoughts in the word cueing paradigm. Across three experiments, we found that future event representations were produced through the same dual mechanisms, direct and generative, as autobiographical memories (Uzer et al., 2012). On the majority (i.e., around 60%) of trials, participants reported that a future event directly came to mind in response to the cue and the prevalence of such direct production of episodic future thoughts was comparable to the prevalence of directly retrieved memories for past events; RT data confirmed that event representations were produced much faster for direct than for generative responses, both for the past and the future. These results were observed not only when direct access was conceptualized in terms of search effort, but also in terms of information use (Experiment 3).

When looking at the determinants of direct responses, we found that most past and future events that were directly produced had already been thought of on a previous occasion, and the frequency of previous thoughts predicted the occurrence of direct access (Experiments 1 & 2). Importantly, however, the future thoughts that were directly produced did not simply consist in remembered past events recasted as future events (Experiment 2) and could more appropriately be conceptualized as "memories of the future," that is, future events that had been envisioned on a previous occasion (Ingvar, 1985; Szpunar et al., 2013). The personal relevance of events was also a significant predictor of the mode of production of autobiographical thoughts, with direct access being more frequent for past and future events that were important and emotionally intense (Experiments 1 & 2). Collectively, these findings provide novel evidence that the direct production of episodic future thoughts is frequent in the word cueing paradigm and often involves the activation of personally significant memories of the future.

Recent theoretical and empirical work on episodic future thinking has emphasized the role of constructive and generative processes in the production of future event representations (e.g., D'Argembeau & Mathy, 2011; Schacter et al., 2012; Suddendorf & Corballis, 2007). While not downplaying the importance of such processes, the present research shows that episodic future thoughts are not necessarily effortfully generated, but instead can come to mind rapidly, with no search effort and information manipulation, in response to a cue (see also Anderson et al., 2012; Berntsen & Jacobsen, 2008; D'Argembeau & Mathy, 2011; Finnbogadottir & Berntsen, 2013, for related observations). Most importantly, however, our data suggest that the direct production of episodic future thoughts mainly occur for events that have already been contemplated on a previous occasion, rather than novel events (i.e., events that have not been previously imagined or experienced). Thus, the mechanisms involved in

the formation of episodic future thoughts seem to critically depend on the types of future events that are produced: effortful constructive processes (e.g., the extraction and flexible recombination of details from past experiences) may mainly be required for simulating *novel* future events (Schacter et al., 2008, 2012), and indeed our previous work suggests that for newly imagined events, the use of generative processes is the dominant mode of production of episodic future thoughts (D'Argembeau & Mathy, 2011). On the other hand, as shown by the present research, when the constraint to imagine a novel event is removed, episodic future thoughts frequently consist in pre-stored representations of previously imagined events that are accessed directly.

While it is true that most of the episodic future thoughts that were produced directly referred to previously imagined events, it is worth noting that some future thoughts were formed directly and yet participants reported that they had not previously thought about the corresponding events; this occurred for 27% and 16% of directly produced future thoughts in Experiments 1 and 2, respectively. These figures align with the previous observation that when participants were explicitly instructed to imagine novel future events, 16% of episodic future thoughts appeared to be formed directly (D'Argembeau & Mathy, 2011, Study 1). Thus, while the notion of memories of the future can account for most instances of direct production of episodic future thoughts, some thoughts do not easily conform to this explanation. This is an intriguing finding and the exact nature of the mechanisms allowing the direct formation of novel episodic future thoughts should be further investigated in future studies. Perhaps some personal goals or concerns are so salient in a person's mind that anticipations and plans related to these goals are formed rapidly and automatically (Klinger, 2013). The finding that providing cues referring to personal goals increases the frequency of direct formation of episodic future thoughts (D'Argembeau & Mathy, Study 3) might be taken

as supporting this idea. Another possibility would be that all events that are produced directly have in fact been constructed on a previous occasion, but in some cases the individual does not remember or was not aware of the previous act of imagination. For example, future thoughts are frequent during mind wandering episodes (e.g., Stawarczyk, Cassol, & D'Argembeau, 2013) but people do not necessarily take explicit note of these thoughts (Schooler et al., 2011), such that they could erroneously be considered novel when subsequently reactivated.

Be it as it may, from a methodological point of view, the present results highlight the importance of instructions in determining the processes by which episodic future thoughts are produced. In some previous studies of episodic future thinking, participants were explicitly instructed to produce novel future events (e.g., Addis, Wong, & Schacter, 2007), whereas novelty was left unspecified in other studies (e.g., D'Argembeau & Van der Linden, 2004). Taken together, the present research and our previous work (D'Argembeau & Mathy, 2011) suggest that these two situations differ in the relative contribution of direct and generative processes to the production of future event representations: generative processes are dominant when event novelty is emphasized, whereas direct access is more frequent when event novelty is left unspecified. This may be an important point to consider when interpreting deficits in the production of episodic future thoughts that are observed in various clinical populations (e.g., Addis, Sacchetti, Ally, Budson, & Schacter, 2009; D'Argembeau, Raffard, & Van der Linden, 2008; Williams et al., 1996).

It is also worth mentioning that, in the present experiments, participants were asked to bring specific future events to mind but did not have to construct detailed mental simulations of these events (e.g., by visualizing the location, persons, objects, and actions involved). Referring to the proposed distinction between construction and elaboration phases of episodic

future thought (Addis et al., 2007), our results mainly pertain to the former phase (i.e., bringing a specific event to mind) and additional work should therefore be conducted to determine whether and to what extent detailed mental simulations of future events can also be formed directly, with no search effort.

The implications of the present findings for hierarchical models of autobiographical memory and future thinking warrant further discussion. According to such models (see e.g., Conway, 2009; Conway & Pleydell-Pearce, 2000; D'Argembeau, 2015), different types of knowledge structures varying in levels of abstraction contribute to past and future thoughts, with knowledge structures at higher levels of abstraction (e.g., broad goals, lifetime periods, and general events) providing information that contextualizes and locates specific event representations. What the present results show is that the production of specific memories and future thoughts does not necessarily involve a top-down search through such a hierarchical knowledge base—in which more abstract representations would be used for constructing specific event representations (Conway & Pleydell-Pearce, 2000). Top-down search processes may be involved in the formation of novel or infrequently considered event representations, but for events that are more frequently part of one's mental landscape, the present data suggest the existence of pre-stored representations that can be directly accessed in response to relevant cues. This does not imply, however, that these event representations are not part of a hierarchical autobiographical knowledge base. In other words, while the present findings argue against the necessity of a hierarchical *search process* in the production of specific event representations, they are neutral with respect to the assumed hierarchical *organization* of autobiographical knowledge. In fact, many past and future event representations are structured in higher-level clusters that organize sequences of causally or thematically related events (Brown, 2005; Brown & Schopflocher, 1998; D'Argembeau & Demblon, 2012; Demblon &

D'Argembeau, 2014), and such higher-order organization could actually promote the direct production of autobiographical thoughts (i.e., the activation of one event within a cluster may tend to automatically trigger other related events). In line with this view, it has been found that pairs of associated events are produced faster when the events are part of the same cluster (Brown & Schopflocher, 1998).

Finally, we note that the direct and rapid access to previously imagined events may be an important factor in the adaptive value of prospection. Episodic future thought allows the anticipation and simulation of potential goal-relevant events and actions (i.e., events and actions that are conductive or obstructive to reaching personal goals), which in turn can inform decisions and plans and, ultimately, guide behavior (D'Argembeau & Mathy, 2011; Schacter, 2012; Suddendorf & Corballis, 2007; Taylor, Pham, Rivkin, & Armor, 1998). Successful goal pursuit may depend, in part, on the ability to remember the content of anticipated events, plans, and outcomes (Ingvar, 1985; Szpunar et al., 2013), and the rapid access to such representations may help guide behavior more efficiently and effectively. In other words, successful goal pursuit may benefit from mechanisms that make goal-related future thoughts highly accessible, such that they can be automatically triggered when a relevant (internal or external) cue is encountered. The present research provides preliminary support for the existence of such mechanisms, by showing that episodic future thoughts that are considered more important (thus presumably involving goal-related contents) are more frequently formed in a fast and direct way.

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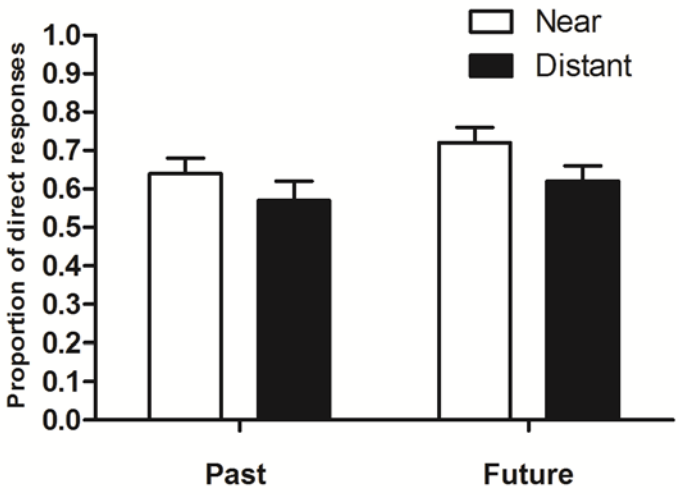
Figure captions

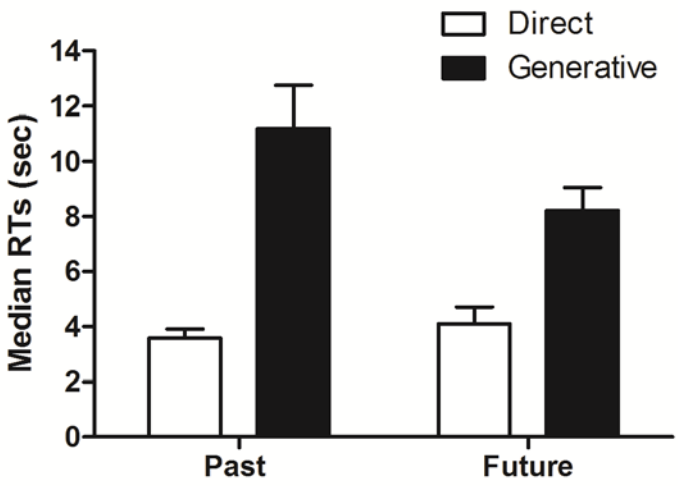
Figure 1. Mean proportion of direct responses reported for near and distant past and future events in Experiment 1. Error bars represent the standard error of the mean.

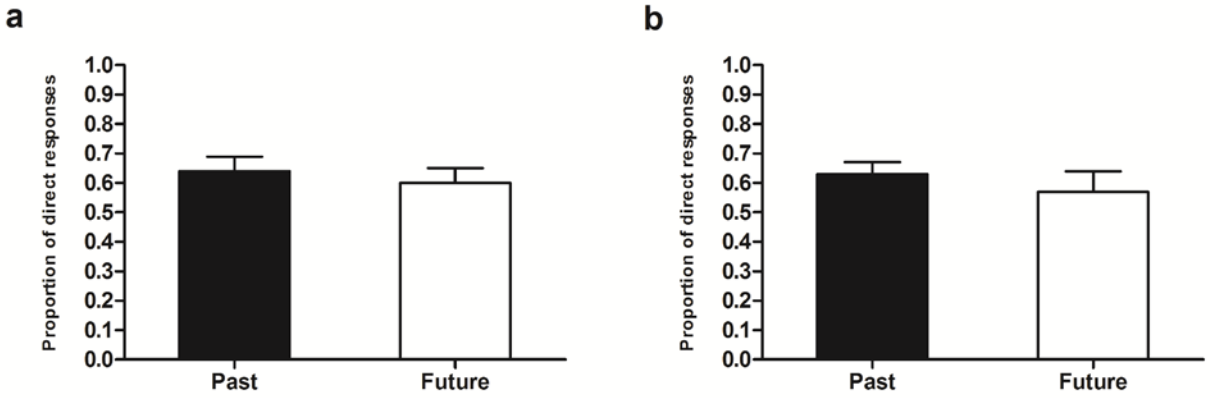
Figure 2. Median response times as a function of the mode of production (direct vs. generative) and temporal orientation (past vs. future) of events in Experiment 1. Error bars represent the standard error of the mean.

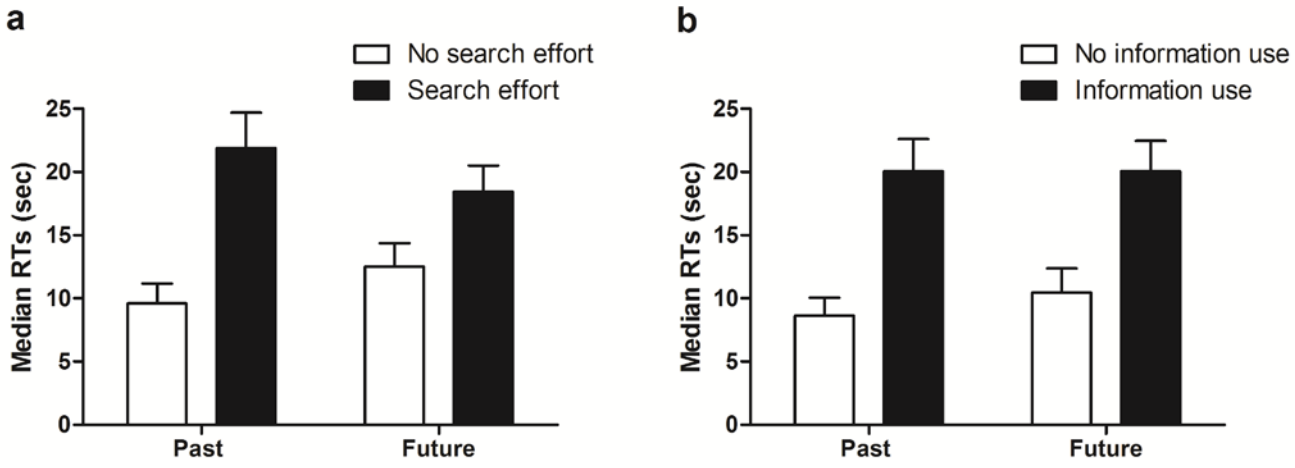
Figure 3. Mean proportion of past and future events that (a) were produced with no search effort and (b) came immediately to mind (without accessing general information) in Experiment 3. Error bars represent the standard error of the mean.

Figure 4. Median response times for past and future events as a function of (a) search effort and (b) information use in Experiment 3. Error bars represent the standard error of the mean.


Near
Distant
Proportion of direct responses
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Past
Future


Direct
Generative
Median RTs (sec)
14
12
10
8
6
4
2
0
Past
Future


a
Proportion of direct responses
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Past
Future
b
Proportion of direct responses
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Past
Future


a
No search effort
Search effort
Median RTs (sec)
25
20
15
10
5
0
Past
Future
b
No information use
Information use
Median RTs (sec)
25
20
15
10
5
0
Past
Future