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The role of self-reference and personal goals in the formation of memories of the future

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Abstract

Recent evidence suggests that some simulations of future events are encoded in memory and later recalled as "memories of the future," but the factors that determine the memorability of future simulations remain poorly understood. The current research aimed to test the hypothesis that imagined future events are better memorized when they are integrated in autobiographical knowledge structures. Across two experiments, we found that future events that involved the self were better recalled than future events that involved an acquaintance (Experiment 1), and that future events that were related to personal goals were better recalled than future events that were unrelated to goals (Experiment 2). Although self-reference and personal goals influenced the phenomenological characteristics of future simulations (e.g., their vividness and the clarity of event components), the enhanced recall of self-relevant and goal-relevant simulations was not simply due to these differences in the characteristics of simulations. Taken together, these findings suggest that the integration of simulated events with preexisting autobiographical knowledge is an important determinant of memories of the future.

Keywords Autobiographical memory · Episodic future thinking · Episodic memory · Self-reference · Personal goals

The ability to project oneself into the future to imagine possible events—referred to as *episodic future thinking* (Atance & O'Neill, 2001; Szpunar, 2010)—has attracted growing attention in the past decade (for a review, see Schacter et al., 2017). Accumulating evidence has demonstrated that mental simulations of future scenarios are constructed using details from prior experiences (drawn from episodic memory; Schacter & Addis, 2007), as well as semantic knowledge and event schemas (Irish & Piguet, 2013). Once a future simulation has been constructed, the content of the imagined scenario can be retained as a "memory of the future" (Ingvar, 1985), allowing its subsequent use for planning, decision-making, and goal-directed behavior (Kvavilashvili & Rummel, 2020; Szpunar et al., 2013; Szpunar & Jing, 2013). To date, however, the factors that shape memories for future event simulations—and more generally, memory for internal mentation (Stawarczyk & D'Argembeau, 2019; Stawarczyk et al., 2018)—have received relatively little empirical attention. A notable exception is prospective memory (i.e., remembering to perform a planned action at an appropriate moment in the future; McDaniel & Einstein, 2000), but most studies focused on memory for intended actions rather than the contents of future simulations (Szpunar et al., 2014).

A first insight into the factors that contribute to the formation of memories of the future was provided by Szpunar et al. (2012), who highlighted the role of emotional valence in the encoding of future event simulations in memory. More precisely, they showed that components (i.e., locations, persons, and objects) of positive and neutral future events were better recalled than components of negative future events. They also found that persons were more memorable than locations and objects, thereby suggesting that persons are central components in the formation of memories of future event simulations. Extending this work, McLelland et al. (2015) identified the level of detail and plausibility of imagined future events, as well as the familiarity of event components, as significant predictors of whether future simulations were successfully encoded and later accessible in memory. By manipulating the plausibility of future simulations, van Mulukom et al. (2016) found that imagined future events were more detailed, coherent and memorable when they involved event components (i.e., locations, persons, and objects) that may

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plausibly occur together in future scenarios compared with more disparate event components. Finally, Jeunehomme and D'Argembeau (2017) provided evidence that the clarity and familiarity of imagined persons, the feelings of preexperience and of mental time travel, and the personal importance and emotional intensity of imagined events were all significant predictors of memories for future simulations.

Although these studies shed some light on the determinants of memories for future simulations, the exact mechanisms of their formation remain poorly understood. In the present study, we aimed to investigate the extent to which memories of the future depend on the integration of simulated events with preexisting autobiographical knowledge. A recent theoretical framework has emphasized the role of autobiographical knowledge in episodic future thinking, arguing that personal goals and general expectations about one's personal future form a cognitive representational system—a personal timeline—onto which imagined events can be mapped (D'Argembeau, 2020). According to this view, autobiographical knowledge guides and constrains episodic future thinking and may also contribute to integrate and maintain imagined future events in long-term memory structures. Here, we tested this hypothesis by investigating whether the formation of memories of the future depends on two dimensions of future simulations: their self-reference and their relation to personal goals.

The role of self-reference in memory is well documented. In particular, a robust *self-reference effect* (SRE) has been described (Rogers et al., 1977), manifesting through a better memory when information is encoded in relation to the self, compared with other persons (for a review, see Klein, 2012; Symons & Johnson, 1997). For example, trait adjectives that have been judged in reference to oneself ("Does this adjective describe you?") are better recalled than adjectives that have been judged in reference to another person (e.g., "Does this adjective describe Walter Cronkite?"; Bower & Gilligan, 1979). To account for the mechanisms underlying the SRE, Klein and Loftus (1988) proposed that this effect takes its roots in organizational and elaborative processing: The self is a well-developed and often-used knowledge structure that promotes elaboration and organization of encoded information. In line with this view, the SRE is smaller when the self is compared with a highly intimate other; the more well known the person referenced is, the more organized and elaborated the encoded information about the person (Symons & Johnson, 1997). More recent work on autobiographical memory has also highlighted the role of the self in memory (e.g., Conway & Pleydell-Pearce, 2000; Fivush, 2011; Howe et al., 2003; Prebble et al., 2013; Wilson & Ross, 2003). A core postulate of these approaches is that the self mediates the integration of personal experiences with preexisting autobiographical knowledge structures, thereby enhancing their maintenance and later accessibility.

Self-representation is not limited to memories and factual knowledge about the personal past but also includes ideas about what one might become, would like to become, and is afraid of becoming in the future (Markus & Nurius, 1986). As with memories of past experiences, autobiographical knowledge structures contribute to link and organize future simulations in coherent event sequences that can be mapped onto a personal future timeline (D'Argembeau, 2020; D'Argembeau & Demblon, 2012; Demblon & D'Argembeau, 2014), and maintaining future simulations—especially "*self-defining future projections*" (D'Argembeau et al., 2012)—available in memory may be important in providing a sense of personal continuity and purpose in one's life. Accordingly, memories for future scenarios might benefit from a similar self-reference effect as memories for past events: highly self-relevant future events might be better integrated with preexisting autobiographical knowledge, leading to superior memory compared with less self-relevant future scenarios.

Looking further at the contribution of autobiographical knowledge in future thinking, recent studies have shown that personal goals play important roles in imagining specific events that might happen in one's personal future (i.e., episodic future thoughts). Personal goals facilitate the construction and elaboration of episodic future thoughts (Anderson et al., 2015; D'Argembeau & Mathy, 2011) and support the organization of imagined events in coherent themes and sequences (D'Argembeau & Demblon, 2012; Demblon & D'Argembeau, 2014). The intimate link between personal goals and episodic future thinking is also highlighted by neuroimaging studies showing that thinking about personal goals and imagining specific future events are associated with common brain activation (for a meta-analysis, see Stawarczyk & D'Argembeau, 2015). This empirical evidence led several researchers to propose that one of the most important adaptive functions of human memory is to provide information that is relevant for planning future contingencies and goal pursuit (Conway, 2009; Kvavilashvili & Rummel, 2020; Klein et al., 2002; Klein et al., 2010; Suddendorf & Corballis, 2007). Therefore, future event simulations might be better encoded and retained in memory when they are related to personal goals.

In summary, previous studies suggest that the depth of integration of future event simulations with autobiographical knowledge may enhance their memorability, although direct evidence for this is lacking. To address this question, we conducted two studies investigating the formation of memories for future event simulations characterized by various degrees of self-reference (Experiment 1) and relation to personal goals (Experiment 2).

EXPERIMENT 1

The main aim of Experiment 1 was to investigate the extent to which memory for future event simulations depends on their degree of self-reference. To this end, we asked participants to imagine future events that involved the self, a close friend, or an acquaintance, and then to recall these events one week later. We expected that events involving the self would be better recalled, presumably because preexisting autobiographical knowledge promotes elaboration and organization of encoded information (Klein, 2012; Symons & Johnson, 1997). Furthermore, given evidence that the SRE is reduced, if not eliminated entirely, when information is encoded in reference to a highly intimate person (e.g., Bower & Gilligan, 1979; for a review, see Symons & Johnson, 1997), we expected that the SRE in memory of the future would be reduced, and perhaps even eliminated, when comparing future events involving the self with future events involving a close friend.

Several studies have shown that some phenomenological properties of memories and future simulations (such as vividness, sensory details, and emotional intensity) are enhanced by self-reference (e.g., de Vito et al., 2012; Grysman et al., 2013; Thomsen & Pillemer, 2017; for evidence of the importance of phenomenological properties of past and future simulations, see Viard et al., 2012). Our second aim was therefore to examine whether the impact of self-reference on memory for future simulations can be accounted for by such differences in the phenomenological characteristics of imagined events. In line with previous studies, we predicted that future events involving the self would be associated with more detailed event representations (e.g., enhanced vividness and clarity of components). However, we expected that the effect of self-reference on memory would not be entirely accounted for by these differences because, as detailed above, we hypothesized that this effect is mainly due to the integration of future simulations with preexisting autobiographical knowledge.

Finally, in addition to the proportion of recalled events, we examined whether some categories of event components (i.e., locations, persons, objects, actions, and emotions) are better recalled than others, and whether this is influenced by self-reference. Taking into account the central role of persons in past and future event representations as well as in memories for future thoughts (Dijkstra & Misirlisoy, 2006; Jeunehomme & D'Argembeau, 2017; McLelland et al., 2015; Szpunar et al., 2012), we predicted that person components constituting future event simulations would be well remembered for the three kinds of simulated events. Furthermore, in line with Jeunehomme and D'Argembeau (2017), and considering that the construction of past and future events relies heavily on scene construction processes (Hassabis & Maguire, 2007; Robin & Moscovitch, 2014), we expected that locations would also be well recalled. On the other hand, we had no specific hypothesis regarding the impact of self-reference on memory for different types of event components.

Method

Participants

In total, 40 undergraduate students, between the ages of 18 and 30 years, took part in this study, but some of them were excluded for the following reasons: one participant because of a noncompliance with experimental instructions and four participants because they guessed that their memory of imagined future events would be tested. The final sample consisted of 35 participants (23 females; mean age = 24 years, SD = 1.9 years).[1] Forty participants were tested to ensure that at least 34 participants would be included in the final sample; this sample size was determined a priori using G*Power 3 (Faul et al., 2007) to achieve a statistical power of 80%, considering an alpha error of .05, and a medium within-subject effect size (d = 0.50). All participants provided written informed consent and the study was approved by the local Ethics Committee.

Materials and procedure

The experiment involved two sessions that occurred one week apart: in the first session, participants imagined a series of future events that involved the self, a close other, or a nonclose other; in the second session, their memory for previously imagined events was assessed.

Imagination task At the beginning of the first session, participants were invited to select a close friend and an acquaintance of the same sex and of similar age as themselves (in order to match the three reference persons on these two dimensions). The close friend had to be someone that they had known for at least 2 years, that they regularly meet, with whom they share personal confidences, and with whom they regularly engage in extracurricular activities (e.g., sports). The acquaintance had to be someone they know for less than two years, that they do not regularly meet, and with whom they do not share personal confidences nor engage in extracurricular activities.

Participants were then asked to imagine a series of future events that might reasonably happen to them, to their close friend and to their acquaintance. For each condition, participants were instructed to imagine five future events that might happen within the next year, but after the next week. They were also informed that the imagined future events should be specific (i.e., unique events taking place in a specific place at a

[1] Although we did not initially plan to investigate gender differences, following a reviewer's suggestion, we explored whether recall performance differed as a function of gender. There was no significant difference between men and women, and thus we report data collapsed across gender.

specific time and lasting a few minutes or hours, but not more than a day) and novel (i.e., events that had not already occurred in the past and that participants had not previously thought about). Moreover, it was specified that the two selected persons (i.e., the close friend and the acquaintance) should not be part of the imagined events in the self condition; similarly, imagined future events in the close-friend and acquaintance conditions should not involve the two other persons (i.e., the self and acquaintance other in the close-friend condition and the self and close other in the acquaintance condition). As soon as an adequate future event came to their mind, participants were invited to verbally describe the imagined event in as much detail as possible and were explicitly asked to include details about locations, actions, people, objects, and emotions. There was no time limit to describe events. A digital audio recorder was used to record event descriptions for subsequent analyses.

Immediately after each future event description, participants were instructed to keep the event in mind and to rate the phenomenological characteristics of their mental representation. More precisely, participants assessed the vividness of their future event representation (from 1 = *not at all*, to 7 = *extremely vivid*), the subjective amount of visual and other sensory details (from 1 = *not at all*, to 7 = *a lot*), the clarity of imagined persons, locations, and objects (from 1 = *not at all*, to 7 = *extremely clear*) and their respective familiarity (from 1 = *not at all*, to 7 = *extremely familiar*), the easiness of imagination (from 1 = *not at all*, to 7 = *extremely easy*), the probability that the imagined event will actually occur in the future (from 1 = *extremely weak*, to 7 = *extremely strong*), their belief in the future occurrence of the event (from 1 = *not at all*, to 7 = *a lot*), and the visual perspective of their mental representation (from 1 = *totally through my eyes*, to 7 = *totally through an external point of view*). Finally, participants estimated when the event would reasonably occur (in days, weeks, and months).

Before starting the imagination task, participants performed one practice trial to ensure that they understood all instructions and to familiarize them with the procedure. The practice trial was followed by a discussion with the experimenter to ensure that all instructions were correctly understood. The order of presentation of the self, close-friend, and acquaintance conditions was counterbalanced across participants.

Recall task One week later, participants returned to the laboratory and were presented with an unexpected free recall task. More specifically, they were asked to recall as many previously imagined future events as possible. For each future event they remembered, they were instructed to verbally describe the previously imagined event with as much detail as possible concerning the location where the event would occur, the persons and objects involved, the actions that would take place, and their feelings. As in the imagination task, a digital audio recorder was used to record event descriptions.

Immediately after having described each event, participants were instructed to keep their memory for the future event in mind to rate associated phenomenological characteristics. As in the imagination task, they rated the vividness of their memory (from 1 = *not at all*, to 7 = *extremely vivid*), the subjective amount of visual and other sensory details (from 1 = *not at all*, to 7 = *a lot*), the clarity of remembered persons, location, and objects (from 1 = *not at all*, to 7 = *extremely clear*), and the easiness of remembering (from 1 = *not at all*, to 7 = *extremely easy*). Furthermore, participants were also asked to report whether they had thought about the future event during the previous week (by answering "yes" or "no"; if they responded "yes," they were asked to specify to what extent they thought about this event, from 1 = *rarely*, to 7 = *very often*). Finally, participants were debriefed and were asked whether they had expected that their memory for the imagined events would be tested.

Scoring The first author first checked that the future events reported during the imagination task were specific (i.e., events happening in a specific place at a specific time and lasting no longer than a day); only specific events were considered in the analyses. Then, he scored the number of distinct event components reported during the imagination task for five categories of components (i.e., *locations*, *persons*, *objects*, *actions,* and *emotions*) that have been identified in previous studies of autobiographical memory and future thinking (see, e.g., Dijkstra & Misirlisoy, 2006; Lancaster & Barsalou, 1997; McLelland et al., 2015). For example, an imagined event could involve one location, two persons, one action, three objects, and one emotion. The number of events that were correctly recalled was then assessed and, for each recalled event, the proportion of recalled components was computed for each of the five categories of interest. For most event components, the descriptions provided in the imagination and recall tasks could be easily mapped (e.g., "my apartment"), but when a component was only loosely described during the imagination task (which happened rarely, as participants were instructed to describe their mental representation as precisely as possible), it was considered as correctly recalled only when it was described using the exact same words during the recall task. For example, a person component that was described as "my usual group of friends" in the imagination task was scored as correctly recalled only if the participant reported "my usual group of friends" at recall (of course, additional information could also be provided, such as the name of these friends).

To assess the reliability of coding, another trained rater independently scored the number of components of each type produced during the imagination task and the proportion of components that were later recalled, from a random selection of 20% of events. Intraclass correlation coefficients (ICCs) showed a strong agreement regarding the number of imagined elements for all categories of components (locations = .89, persons = .89, objects = .88, actions = .81, emotions = .85). Furthermore, ICCs for the proportion of recalled elements in each category revealed an almost perfect agreement for locations (.99) and a strong agreement for persons (.87), objects (.76), actions (.95) and emotions (.77).

Statistical analyses Because the distribution of several behavioral and phenomenological measures (e.g., the number of imagined event components and their clarity) were substantially skewed, we used robust statistical methods to analyze the data; these methods perform well in terms of Type I error control and statistical power, even when the normality and homoscedasticity assumptions are violated (Erceg-Hurn & Mirosevich, 2008; Wilcox, 2012). More specifically, we conducted a series of robust one-way and two-way repeated-measures analyses of variance (ANOVAs), as well as Yuen's *t* tests. These statistical tests are robust versions of traditional repeated-measures ANOVAs and Student's *t* tests that use trimmed means (here, we used 20% trimmed means, as recommended by Field & Wilcox, 2017). Effect sizes were estimated using the explanatory measure of effect size ξ: values of 0.10, 0.30, and 0.50 correspond to small, medium, and large effect sizes (Mair & Wilcox, 2019). To investigate whether self-reference had an effect on memory for future simulations when differences in the phenomenological characteristics of imagined events were taken into account, we conducted a multilevel logistic regression analysis (with events as Level 1 units and participants as Level 2 units) with the recall of imagined future events as outcome variable and each measure of interest as predictor (see Results). The analyses were performed using the functions of Wilcox (2012) and the lme4 package (Bates et al., 2015) implemented in R (R Core Team, 2013). All descriptive statistics refer to the 20% trimmed means and their 95% confidence intervals calculated using the percentile bootstrap method (with 2,000 bootstrap samples; Wilcox, 2012). The data that support the findings of this study are openly available in OSF (https://osf.io/23a79/).

Results

In total, the 35 participants reported 525 future events. However, nine future events (from seven participants) were excluded because they did not refer to a specific episode, thus leaving 516 future events for the analyses (the mean number of future events reported by participants was 14.74, SD = 0.56). Among these, 50 events (9%) involved no person other than the main character (i.e., the self, close friend, or acquaintance); therefore, these events had to be excluded when analyzing data about person components. Similarly, five events (1%) lacking object descriptions, four events (1%) lacking action descriptions, and 20 events (4%) lacking emotion descriptions were excluded from the analyses involving these components.

Characteristics of future event representations during the imagination task

Event components Robust location measures (20% trimmed means and their 95% CI) for the numbers of components constituting imagined future events are shown in Table 1 for the three types of events. A 3 (type of events) × 5 (type of components) robust repeated-measures ANOVA yielded no main effect of the type of events, Q = 0.95, p = .388, but a main effect of the type of components, Q = 126.77, p < .001, which was qualified by a significant interaction between the type of events and type of components, Q = 2.86, p = .004. Follow-up Yuen's *t* tests showed that future events involving the self included more emotions than future events involving a close friend (t = 2.82, p = .011, ξ = .40) or an acquaintance (t = 2.14, p = .045, ξ = .31), whereas future events involving a close friend involved more objects than future events involving the self (t = 3.00, p = .007, ξ = .27). There was no significant difference between the three types of events for the other event components.

Phenomenological characteristics Robust location measures for each phenomenological characteristic of imagined future events in the three conditions are shown in Table 2. To investigate possible differences between future events involving the self, the close friend, and the acquaintance, we computed a series of one-way (type of events) robust repeated-measures ANOVAs on each phenomenological characteristic; correction for multiple comparisons were made using the Benjamini–Hochberg procedure, which controls the expected proportion of falsely rejected hypotheses (here, a false discovery rate of .05 was used; Benjamini & Hochberg, 1995). The results showed that several phenomenological characteristics differed between the three types of events (see Table 2 for Q and p values). Follow-up Yuen's *t* tests showed that events involving the self and the close friend were rated as more vivid (t = 3.87, p = .001, ξ = .55, and t = 2.75, p = .012, ξ = .34, respectively) and characterized by clearer persons (t = 6.63, p < .001, ξ = .80, and t = 9.24, p < .001, ξ = .89, respectively) and objects (t = 4.38, p < .001, ξ = .52, and t = 2.47, p = .023, ξ = .26, respectively) than events involving the acquaintance. Events about the self and close friend were also rated as involving more familiar persons (t = 9.29, p < .001, ξ = .89, and t = 8.56, p < .001, ξ = .86, respectively) than events involving the acquaintance. Moreover, compared with events in the close-friend and acquaintance conditions, events in the self condition were more often reported from a first-person perspective (t = 7.39, p < .001, ξ = .80, and t = 9.33, p < .001, ξ = .90, respectively) and

Table 1 Number of event components described in imagined future events for the self, close friend, and acquaintance conditions

	Self Trimmed mean [95% CI]	Close friend Trimmed mean [95% CI]	Acquaintance Trimmed mean [95% CI]
Locations	1.01 [1.00, 1.06]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Persons	1.71 [1.54, 1.90]	1.68 [1.53, 1.83]	1.59 [1.45, 1.74]
Objects	3.16 [2.92, 3.56]	3.78 [3.49, 4.13]	3.50 [3.06, 3.98]
Actions	2.37 [2.15, 2.63]	2.52 [2.16, 2.90]	2.55 [2.30, 2.79]
Emotions	1.72 [1.56, 1.93]	1.44 [1.33, 1.62]	1.54 [1.43, 1.65]

involved more other (nonvisual) sensory details ($t = 3.26$, $p = .004$, $\xi = .31$, and $t = 4.01$, $p < .001$, $\xi = .45$, respectively).

Memory for future simulations

Proportion of recalled future events First, we examined the proportion of recalled future events in the three event conditions. Robust location measures (20% trimmed means and their 95% CI) for proportions of freely recalled events are shown in Fig. 1. As can be seen, on average, more than half of future events that had been imagined 1 week earlier were reported during the free recall task in all conditions. A one-way robust repeated-measures ANOVA yielded a significant main effect of event type, $Q = 4.80$, $p = .013$, and follow-up comparisons (Yuen's t tests) revealed that more events were recalled in the self condition than in the acquaintance condition ($t = 3.43$, $p = .003$, $\xi = .51$); the differences between the self and close-friend conditions and between the close-friend and acquaintance conditions were not statistically significant ($t = 1.99$, $p = .060$, $\xi = .27$ and $t = 0.86$, $p = .400$, $\xi = .16$, respectively). Although the difference between the self and close-friend conditions was not statistically significant, it should be noted that the estimated Bayes factor indicated that the evidence is inconclusive and favors neither the null nor the alternative hypothesis ($BF_{01} = 1.390$).

Given that future simulations that involved the self were more vivid and associated with a higher clarity and familiarity of persons than simulations involving the acquaintance, and that previous studies showed that these dimensions predicted memory for future simulations (Jeunehomme & D'Argembeau, 2017; McLelland et al., 2015), we sought to investigate whether the effect of self-reference reported above remained significant when these dimensions of future simulations were taken into account. To do so, we conducted a multilevel logistic regression analysis with event recall as dependent variable and self-reference (dummy coded, with the

Table 2 Phenomenological characteristics of imagined future events in the self, close friend, and acquaintance conditions

	Self Trimmed mean [95% CI]	Close friend Trimmed mean [95% CI]	Acquaintance Trimmed mean [95% CI]	Q	p
Vividness	4.65 [4.36, 4.96]	4.42 [4.07, 4.77]	3.88 [3.54, 4.25]	8.84	<.001*
Clarity					
Persons	4.50 [4.07, 4.90]	4.49 [4.17, 4.80]	2.79 [2.54, 3.16]	37.03	<.001*
Locations	4.49 [4.08, 4.81]	4.41 [4.09, 4.75]	4.02 [3.75, 4.35]	3.25	.052
Objects	4.24 [3.89, 4.57]	3.93 [3.59, 4.34]	3.57 [3.26, 3.92]	10.45	<.001*
Familiarity					
Persons	4.81 [4.29, 5.22]	4.49 [3.99, 4.94]	2.34 [1.95, 2.69]	55.14	<.001*
Locations	3.19 [2.65, 3.69]	3.15 [2.78, 3.60]	3.30 [2.90, 3.72]	0.20	.807
Objects	3.68 [3.36, 4.06]	3.65 [3.22, 4.07]	3.29 [2.89, 3.68]	2.64	.084
Visual details	4.77 [4.45, 5.09]	4.63 [4.27, 5.01]	4.37 [4.05, 4.67]	3.10	.056
Other sensory details	3.78[3.33, 4.17]	3.19 [2.78, 3.62]	2.95 [2.55, 3.41]	10.90	<.001*
Ease of imagination	3.05 [2.71, 3.28]	3.05 [2.88, 3.24]	3.49 [3.31, 3.68]	4.69	.021
Probability of occurrence	3.96 [3.59, 4.34]	3.93 [3.67, 4.20]	3.57 [3.15, 3.94]	2.28	.115
Belief in occurrence	3.80 [3.41, 4.27]	3.58 [3.24, 3.91]	3.22 [2.81, 3.56]	3.74	.035
Visual perspective	2.93 [2.32, 3.50]	5.61 [5.10, 6.12]	6.17 [5.71, 6.54]	55.89	<.001*
Temporal distance (days)	124 [106, 144]	112 [97, 130]	94 [80, 115]	3.03	.059

Note. All event characteristics are measured on a scale ranging from 1 to 7, except temporal distance (measured in days). * indicates differences that are significant after applying a correction for multiple comparisons using the Benjamini–Hochberg procedure (with a false discovery rate of .05).

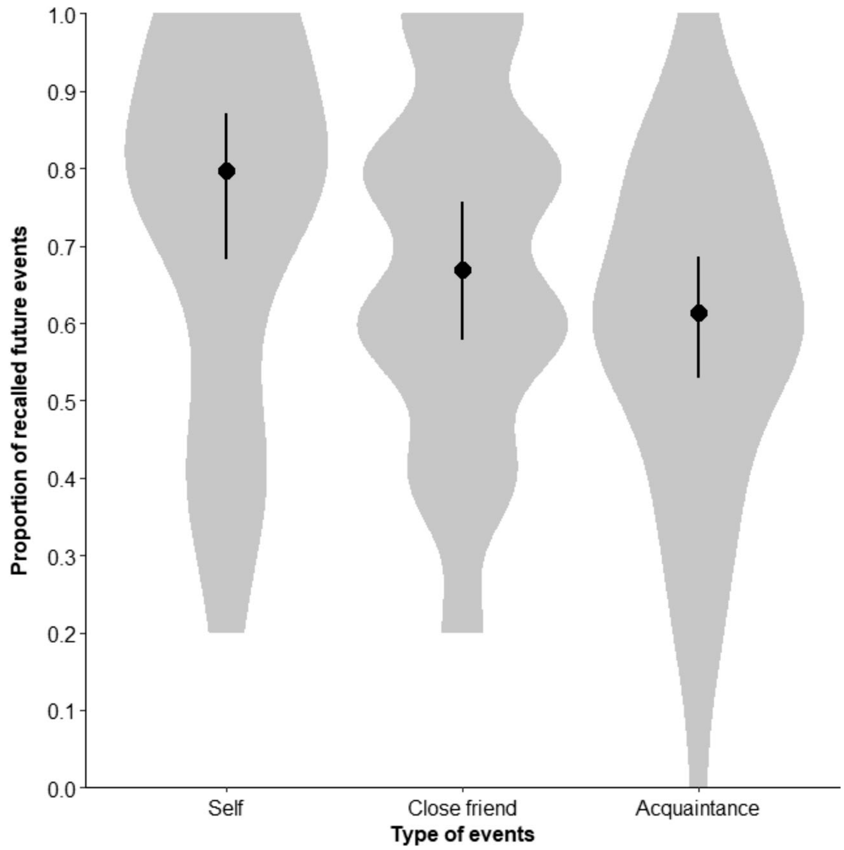

Fig. 1 Proportions of recalled future events in the self, close friend, and acquaintance conditions. Violin plots show the distribution of the data, and point-range plots represent the 20% trimmed means and their 95% robust confidence intervals

acquaintance condition as baseline), vividness, and the clarity and familiarity of persons as predictors (the latter two variable were averaged as they were strongly correlated). As can be seen from Table 3, the enhanced recall of future simulations in the self-reference condition remained significant when these dimensions were taken into account.[2]

Remembered event components Trimmed means for the proportion of recalled event components are presented in Table 4. A 3 (type of events) × 5 (type of components) robust repeated-measures ANOVA yielded a significant effect of the type of events, $Q = 3.11$, $p = .0451$, showing that more event components were recalled when remembering future events related to the self compared with future events related to the acquaintance ($t = 2.09$, $p = .016$, $\xi = .23$). There were no significant differences between future events related to the self and future events related to a close friend ($t = 1.66$, $p = .112$, $\xi = .28$), nor between future events related to a close friend and an acquaintance ($t = 0.24$, $p = .814$, $\xi = .08$). We also found a significant main effect of the type of components, $Q = 184.21$, $p < .001$. Follow-up comparisons (Yuen's t tests) revealed that locations were more often recalled than all other types of components (all ps < .001, and all $\xi > 0.94$); person components were better recalled than objects, actions and emotions ($t = 9.68$, $p < .001$, $\xi = .96$, $t = 10.64$, $p < .001$, $\xi = .87$, and $t = 11.38$, $p < .001$, $\xi = .95$, respectively); objects and actions did not differ from each other ($t = 0.29$, $p = .773$, $\xi = .05$), but both were better recalled than emotions ($t = 3.56$, $p = .002$, $\xi = .59$ and $t = 3.26$, $p = .004$, $\xi = .52$, respectively). The interaction between the type of events and type of components was not significant, $Q = 1.93$, $p = .053$.

Table 3 Logistic regression investigating predictors of the recall of imagined future events in Experiment 1

	b	*SE*	*Z*	*p*
Self-reference	0.68	0.27	2.53	.011*
Vividness	0.01	0.08	0.06	.952
Clarity/familiarity of persons	0.03	0.07	0.38	.702

Note. * indicates predictors that are statistically significant at $p < .05$.

[2] In some additional exploratory analyses, we also examined whether the effect of self-reference remained significant when each of the other the characteristics that differed between conditions (i.e., clarity of objects, other sensory details, visual perspective) were entered as predictors in the regression model. The enhanced recall of future simulations in the self-reference condition remained significant when these dimensions were taken into account.

Table 4 Proportions of recalled event components in the self, close friend, and acquaintance conditions

	Self Trimmed mean [95% CI]	Close friend Trimmed mean [95% CI]	Acquaintance Trimmed mean [95% CI]
Locations	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Persons	0.83 [0.74, 0.89]	0.84 [0.76, 0.90]	0.80 [0.71, 0.88]
Objects	0.55 [0.48, 0.63]	0.42 [0.35, 0.49]	0.53 [0.44, 0.59]
Actions	0.48 [0.43, 0.54]	0.45 [0.34, 0.56]	0.53 [0.45, 0.61]
Emotions	0.40 [0.32, 0.49]	0.34 [0.22, 0.46]	0.28 [0.18, 0.40]

Phenomenological characteristics Finally, we examined whether the subjective characteristics of memories differed between the three event conditions. A one-way robust repeated-measures ANOVA was conducted on each phenomenological characteristic (see Table 5).[3] The only significant difference between conditions involved the clarity of persons, and Yuen's t tests showed that the clarity of persons was higher in the self than in the two other conditions (t = 2.71, p = .013, ξ = .40, and t = 4.43, p < .001, ξ = .64, respectively), and higher in the close other than acquaintance condition (t = 3.20, p = .004, ξ = .46).

Discussion

The first aim of Experiment 1 was to determine to what extent the formation of memories for future event simulations depends of their degree of self-reference. As predicted, we found that future events that involved the self were more often recalled that future events that involved an acquaintance, providing evidence for a SRE in the formation of memories of the future. Although the recall of events involving a close friend was not significantly different from the recall of events involving the self or an acquaintance, proportions of event recall showed a linear decline as function of their degree of self-relevance (see Fig. 1), which is consistent with previous observations that the SRE is reduced when the self is compared with a highly intimate other (e.g., Bower & Gilligan, 1979; for a review, see Simons & Johnson, 1997).

Experiment 1 also replicates previous studies showing that the content and phenomenological properties of future event simulations are influenced by their self-relevance (de Vito et al., 2012; Grysman et al., 2013; Thomsen & Pillemer, 2017). Notably, our results showed that events in the self and close-friend conditions were more vivid and involved clearer and more familiar persons than events in the acquaintance condition. Importantly, however, the effect of self-reference on memory of the future was not simply due to these differences in the phenomenological characteristics of imagined events.

When looking at the content of remembered simulations, we found that locations and persons were the two best recalled event components, which is consistent with previous studies on memories for future simulations (Jeunehomme & D'Argembeau, 2017; McLelland et al., 2015; Szpunar et al., 2012). Self-reference enhanced the global recall of event components (compared with the acquaintance condition), with no interaction with the type of components.

Overall, these findings support the view that self-referent encoding creates links between imagined events and preexisting self-knowledge (Rogers et al., 1977), leading to better memory for future event simulations.

EXPERIMENT 2

The results of Experiment 1 showed a self-reference effect on the formation of memories for future event simulations, such that events involving the self were better recalled than events involving an acquaintance. In Experiment 2, we sought to deepen our understanding of the impact of preexisting autobiographical knowledge on the formation of memories of the future by further examining the specific influence of personal goals. Personal goals play an important role in the construction and organization of episodic future thoughts (Anderson et al., 2015; D'Argembeau & Demblon, 2012; D'Argembeau & Mathy, 2011; Demblon & D'Argembeau, 2014). By creating and strengthening links with autobiographical knowledge, future events that are closely related to personal goals may be better encoded and accessed in memory to ultimately promote future planning and decision-making (Conway, 2009; D'Argembeau, 2020; Kvavilashvili & Rummel, 2020; Klein et al., 2002; Klein et al., 2010). It follows that goal-relevant future simulations should be memorized better than less goal-relevant simulations. To test this hypothesis, in Experiment 2, we examined whether future event simulations that are directly related to participants' personal goals are better recalled than future event simulations that are unrelated to their goals.

[3] Although we examined the proportion of future events that had been rehearsed, we did not analyze rehearsal frequency because the large majority of event simulations had been not thought about during the previous week (i.e., 86%, 96% and 98% for self, close friend, and acquaintance conditions, respectively), leaving insufficient data about rehearsal frequency to perform relevant analyses.

Table 5 Phenomenological characteristics of memories for future events in the self, close friend, and acquaintance conditions

	Self Trimmed mean [95% CI]	Close friend Trimmed mean [95% CI]	Acquaintance Trimmed mean [95% CI]	*Q*	*p*
Vividness	3.70 [3.14, 4.24]	3.44 [3.02, 3.87]	3.30 [2.84, 3.76]	1.89	.164
Clarity					
Persons	4.32 [3.77, 4.43]	3.61 [3.28, 3.94]	2.81 [2.45, 3.28]	13.51	<.001*
Locations	3.66 [3.19, 4.13]	3.50 [3.08, 3.93]	3.50 [3.03, 3.90]	0.42	.661
Objects	3.21 [2.63, 3.77]	3.09 [2.63, 3.46]	2.81 [2.36, 3.35]	2.73	.077
Visual details	3.86 [3.43, 4.46]	3.67 [3.28, 4.18]	3.63 [3.21, 4.19]	1.54	.226
Other sensory details	2.17 [1.78, 2.70]	1.93 [1.56, 2.36]	1.81 [1.40, 2.27]	2.14	.135
Ease of remembering	3.48 [3.01, 3.97]	3.35 [3.01, 3.73]	3.62 [3.25, 4.04]	0.89	.418
Rehearsal	0.14 [0.03, 0.27]	0.04 [0.00, 0.15]	0.02 [0.00, 0.10]	2.42	.113

Note. * indicates differences that are significant after applying a correction for multiple comparisons using the Benjamini–Hochberg procedure (with a false discovery rate of .05).

Moreover, as in Experiment 1, we examined whether the effect of personal goals on memory remains significant when differences in phenomenological characteristics of future event representations are taken into account.

Method

Participants

Forty-one undergraduate students, between the ages of 20 and 28 years, took part in this study, but four participants were excluded because they guessed that their memory of imagined future events would be subsequently tested, thus leaving 37 participants (20 females; mean age = 24 years, *SD* = 2 years) in the final sample (none of them participated in Experiment 1).[4] As in Experiment 1, we initially aimed to reach a sample size of at least 34 participants to achieve a statistical power of 80%, considering an alpha error of .05 and a medium within-subject effect size. All participants provided written informed consent and the study was approved by the local Ethics Committee.

Materials and procedure

As in Experiment 1, Experiment 2 involved two sessions that occurred 1 week apart. In the first session, participants imagined a series of future events that were related to their personal goals and a series of future events that were unrelated to their goals; in the second session, their memory for previously imagined events was assessed.

Personal goal reports At the beginning of the first session, participants were asked to briefly report eight personal goals (Milyavskaya & Werner, 2018). These were defined as personally important projects that the participants frequently thought about and for which they make plans; it was specified that these projects could refer to any life domain (e.g., work, family, or interpersonal relationships). Immediately after having described each personal goal, participants were asked to rate its importance (from 1= *not at all*, to 7 = *extremely important*) and to estimate when they believed that the goal could be achieved (in days, weeks, and months).

Imagination and recall tasks The procedure of the imagination and recall tasks were similar to Experiment 1, with the following modifications. All imagined future events involved the self, but some events were linked to personal goals (in the goal condition), whereas other events were not linked to personal goals (in the no-goal condition). These events were produced in response to sixteen16 cue sentences that were verbally presented by the experimenter. Half of these cue sentences were created based on the written descriptions of previously reported goals and their moment of achievement (e.g., *winning a football competition next month*). The other half of cue sentences did not refer to the participant's personal goals and were created based on cue sentences that were used in previous studies of scene construction and future thoughts (de Vito et al., 2012; Hassabis et al., 2007; Lehner & D'Argembeau, 2016): *Imagine lying on a sunny, crowded beach; Imagine walking in a sunny garden; Imagine sitting in a crowed pub; Imagine standing in the middle of a bustling street market; Imagine walking in a forest; Imagine having fun in an amusement park; Imagine doing a walk in a big city; Imagine visiting a museum*. To match goal-related and goal-unrelated conditions with regard to temporal distance, the time periods used in the goal condition were also used as time periods in the goal-unrelated condition (e.g., *Imagine walking in a sunny garden next month*). The order of presentation of goal-related and goal-unrelated conditions was

[4] There was no significant difference between men and women in recall performance, and thus we report data collapsed across gender.

counterbalanced across participants, and within each condition the cue sentences were presented in random order. In addition to the rating scales used in Experiment 1, participants also assessed their feeling of preexperiencing the event (from 1= *not at all*, to 7 = *completely*), their feeling of mentally travelling in the future (from 1= *not at all*, to 7 = *completely*), the event's emotional valence (from −3 = *very negative*, to 3 = *very positive*) and intensity (from 1 = *not at all*, to 7 = *very intense*), and its personal importance (from 1 = *not at all*, to 7 = *extremely important*). Personal importance was included as a manipulation check and the other scales were included as a previous study showed that goal-related future events were rated as more positive and associated with higher feelings of preexperiencing and mental time travel than goal-unrelated events (Lehner & D'Argembeau, 2016).

Scoring The scoring procedure was the same as in Experiment 1. ICCs showed a strong agreement regarding the number of imagined elements (locations = .80, persons = .91, objects = .85, actions = .80, and emotions = .74), and the proportion of recalled elements (locations = .75, persons = .82, objects = .80, actions = .74, and emotions = .83). The data that support the findings of this study are openly available in OSF (https://osf.io/23a79/).

Results

In total, the 37 participants reported 592 future events. However, 24 future event descriptions (from 15 participants) did not refer to a specific episode and were excluded, thus leaving 568 future events for the analyses (the mean number of future events reported by participants was 15, SD = 0.92). Among these, 68 events (12%) involved no person other than the participant himself or herself; therefore, these events had to be excluded when analyzing data about person components. Similarly, 28 events (5%) lacking object descriptions, five events (1%) lacking action descriptions, and 32 events (6%) lacking emotion descriptions were excluded from analyses involving these components.

Characteristics of future event representations during the imagination task

Event components The numbers of components reported when describing future event representations were similar to Experiment 1 (see Table 6). A 2 (type of events) × 5 (type of components) robust repeated-measures ANOVA yielded a significant main effect of the type of events, Q = 4.93, p = .027, a significant main effect of the type of components, Q = 36.23, p < .001, and a significant interaction between the types of events and components, Q = 2.77, p = .026. Follow-up comparisons (Yuen's t tests) showed that goal-unrelated future events were described with more persons than goal-related future events (t = 2.85, p = .009, ξ = .42), but that these two types of future events were described using similar numbers of locations (t = 0.66, p = .518, ξ = .13), objects (t = 1.42, p = .170, ξ = .19), actions (t = 0.43, p = .672, ξ = .06), and emotions (t = 0.79, p = .441, ξ = .10).

Table 6 Number of event components described for goal-related and goal-unrelated future events

	Goal-related Trimmed mean [95% CI]	Goal-unrelated Trimmed mean [95% CI]
Locations	1.05 [1.02, 1.09]	1.03 [1.00, 1.09]
Persons	1.49 [1.29, 1.67]	1.82 [1.62, 2.01]
Objects	2.24 [1.92, 2.56]	2.50 [2.21, 2.84]
Actions	2.04 [1.79, 2.29]	2.11 [1.84, 2.44]
Emotion	1.32 [1.20, 1.45]	1.38 [1.26, 1.54]

Phenomenological characteristics Robust location measures for the phenomenological characteristics of goal-related and goal-unrelated future events are shown in Table 7. We compared the characteristics of the two kinds of future event representations using a series of Yuen's t tests (with correction for multiple comparisons using the Benjamini–Hochberg procedure). The analyses revealed that goal-related and goal-unrelated events differed in many phenomenological dimensions (see Table 7 for t and p values). More precisely, goal-related future events were rated as more vivid, involving clearer location and objects, more familiar locations, were judged as more important and probable, involved more positive and intense emotions, were more often previously thought about, and were associated with a greater feeling of mental time travel.

Memory for future simulations

Proportion of recalled future events Robust location measures for the proportion of recalled future events are shown in Fig. 2. A Yuen t test showed that participants recalled more goal-related future events than goal-unrelated future events, t = 10.52, p < .001, ξ = .94.

To investigate whether the effect of personal goals remained significant when differences in dimensions that may influence the formation of memories for future simulations were taken into account (Jeunehomme & D'Argembeau, 2017; McLelland et al., 2015; Szpunar et al., 2012), we conducted a multilevel logistic regression analysis, with event recall as a dependent variable and personal goals (dummy coded, with the goal-unrelated condition as baseline), vividness, clarity, and familiarity of location (these two variables were averaged, as they were strongly correlated), clarity of objects, emotional valence, and intensity as predictors. As

Table 7 Phenomenological characteristics of goal-related and goal-unrelated future events.

	Goal-related Trimmed mean [95% CI]	Goal-unrelated Trimmed mean [95% CI]	t	p	ξ
Vividness	4.46 [4.15, 4.77]	4.02 [3.76, 4.31]	3.33	.003*	0.34
Clarity					
Persons	4.47 [4.17, 4.87]	4.83 [4.50, 5.15]	2.15	.043	0.26
Location	4.14 [3.81, 4.44]	3.65 [3.46, 3.85]	2.67	.014*	0.42
Objects	4.18 [3.85, 4.46]	3.71 [3.57, 3.91]	3.84	<.001*	0.43
Familiarity					
Persons	4.75 [4.38, 5.11]	4.94 [4.45, 5.44]	0.75	.462	0.10
Location	3.31 [2.98, 3.65]	2.56 [2.34, 2.79]	3.96	<.001*	0.55
Objects	3.85 [3.48, 4.20]	3.50 [3.16, 3.76]	1.59	.127	0.25
Visual details	4.54 [4.24, 4.79]	4.44 [4.16, 4.68]	1.10	.284	0.09
Other sensory details	3.12 [2.75, 3.54]	3.34 [2.94, 3.72]	1.44	.163	0.12
Ease of imagination	2.92 [2.67, 3.22]	3.17 [2.90, 3.45]	1.90	.070	0.20
Emotional valence	1.54 [1.26, 1.81]	0.84 [0.66, 1.05]	5.05	<.001*	0.59
Emotional intensity	3.84 [3.35, 4.29]	2.90 [2.61, 3.16]	5.59	<.001*	0.55
Personal importance	5.19 [4.94, 5.45]	2.33 [2.00, 2.70]	15.00	<.001*	0.91
Probability of occurrence	4.96 [4.68, 5.19]	4.01 [3.72, 4.27]	5.16	<.001*	0.76
Previous thoughts about the event	2.28 [1.85, 2.88]	1.32 [1.11, 1.63]	4.38	< .001*	0.58
Feeling of preexperiencing	4.09 [3.71, 4.48]	3.77 [3.45, 4.06]	2.03	.055	0.22
Feeling of mental time travel	4.06 [3.68, 4.43]	3.47 [3.18, 3.81]	4.06	<.001*	0.37
Subjective distance	4.38 [4.19, 4.57]	4.50 [4.24, 4.83]	0.71	.485	0.14
Distance (days)	1101 [890, 1353]	967 [769, 1206]	1.91	.069	0.15

Note. All event characteristics are measured on a scale ranging from 1 to 7, except emotional valence (measured on a scale ranging from −3 to 3) and temporal distance (measured in days). * indicates differences that are significant after applying a correction for multiple comparisons using the Benjamini–Hochberg procedure (with a false discovery rate of .05).

can be seen from Table 8, the enhanced recall of goal-related simulations compared with simulations that were unrelated to personal goals remained significant when these dimensions were taken into account.[5]

Remembered event components Proportions of recalled event components are presented in Table 9. A 2 (type of events) × 5 (type of components) robust repeated-measures ANOVA yielded no significant effect of the type of events, $Q = 1.83$, $p = .177$. However, there was a significant main effect of the type of components, $Q = 44.91$, $p < .001$, and a significant interaction between the type of events and type of components, $Q = 6.56$, $p < .001$. Follow-up comparisons (Yuen t tests) showed that emotions were more often recalled for goal-related than for goal-unrelated future events ($t = 3.78$, $p = .001$, $\xi = .51$), whereas locations were more often recalled for goal-unrelated than for goal-related events ($t = 4.66$, $p < .001$, $\xi = .61$).

Phenomenological characteristics Finally, we examined differences in the phenomenological characteristics of the two types of future event memories by computing a series of Yuen's t tests on each phenomenological characteristic.[6] As shown in Table 10, after applying correction for multiple comparisons, we found that goal-related events were remembered with a higher location clarity and a greater emotional intensity, and had been more often rehearsed and shared than goal-unrelated events.

Discussion

In Experiment 2, we sought to delve deeper in the understanding of the impact of links between future

[5] We also examined whether the effect of goal relevance remained significant when the characteristics of events (personal importance, probability of occurrence) that differed between conditions, as well as previous thoughts, were taken into account. To do so, these dimensions were introduced individually as predictors in the regression model. The enhanced recall of future simulations in the goal-related condition remained significant when these dimensions were taken into account.

[0] Although we also measured the frequencies of rehearsal and sharing of reported future events, the majority of event simulations were not thought about (i.e., 80% and 96% for goal-related and goal-unrelated events, respectively) or shared (91% and 100% for goal-related and goal-unrelated events, respectively) during the previous week, leaving insufficient data to perform analyses on these two variables.

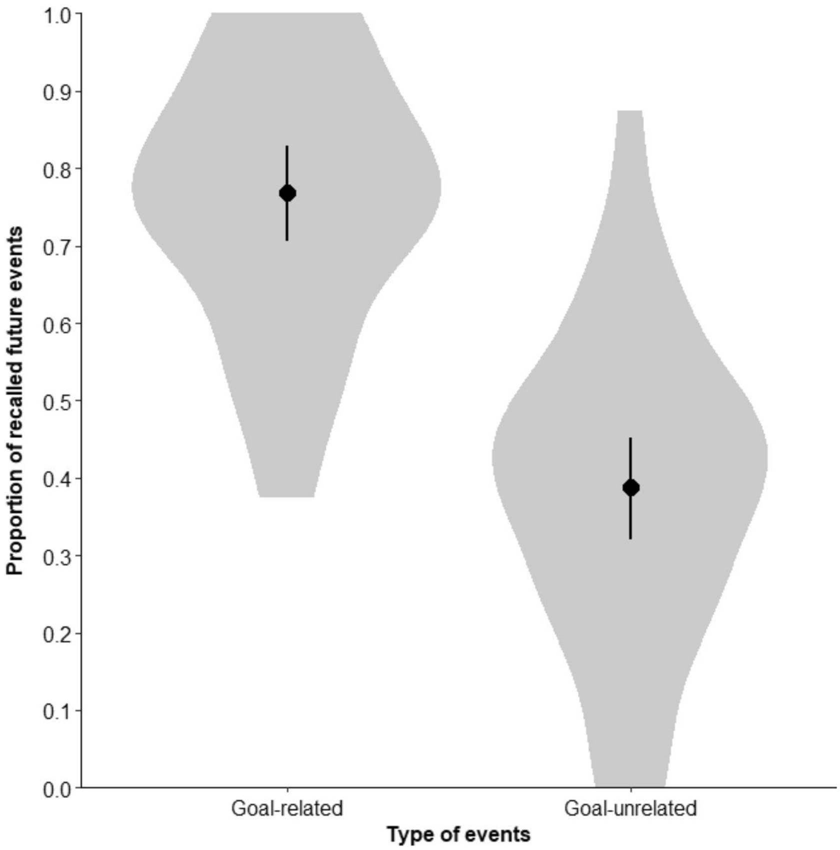

Fig. 2 Proportions of recalled future events in the goal-related and goal-unrelated conditions. Violin plots show the distribution of the data, and point-range plots represent the 20% trimmed means and their 95% robust confidence intervals

thoughts and preexisting autobiographical knowledge on the formation of memories of the future by examining the specific influence of personal goals. Results showed that the percentage of future simulations that were recalled was substantially higher for events directly related to personal goals (i.e., 77%) than events that were unrelated to these goals (i.e., 39%), thereby providing evidence that personal goals enhance the encoding and subsequent accessibility of episodic future simulations in memory.

When examining the characteristics of future event simulations, we found that personal goals enhanced the phenomenological characteristics of event representations, including vividness, clarity of imagined location and objects, location familiarity, personal importance, and probability of occurrence. Moreover, references to personal goals also led to the imagination of future simulations that involved more positive and intense emotions, and a greater feeling of mental time travel. However, as for the effect of self-reference (Experiment 1), the effect of goal-relevance on memory for future simulations remained significant when these

Table 8 Logistic regression investigating predictors of the recall of imagined future events in Experiment 2

	b	*SE*	*Z*	*p*
Personal goals	1.63	0.20	8.12	<.001*
Vividness	−0.06	0.08	−0.82	0.413
Clarity/familiarity of location	0.01	0.06	0.01	0.993
Clarity of objects	0.04	0.07	0.64	0.524
Emotional valence	−0.02	0.07	−0.28	0.781
Emotional intensity	0.04	0.07	0.539	0.590

Note. * indicates predictors that are statistically significant at $p < .05$.

Table 9 Proportions of recalled event components in the goal-related and goal-unrelated conditions.

	Goal-related Trimmed mean [95% CI]	Goal-unrelated Trimmed mean [95% CI]
Locations	0.81 [0.74, 0.88]	1.00 [0.93, 1.00]
Persons	0.78 [0.70, 0.84]	0.79 [0.68, 0.88]
Objects	0.51 [0.44, 0.57]	0.47 [0.37, 0.58]
Actions	0.72 [0.65, 0.78]	0.61 [0.50, 0.73]
Emotions	0.59 [0.50, 0.67]	0.38 [0.27, 0.48]

Table 10 Phenomenological characteristics of goal-related and goal-unrelated memories of the future

	Goal-related Trimmed mean [95% CI]	Goal-unrelated Trimmed mean [95% CI]	*t*	*p*	ξ
Vividness	3.36 [3.04, 3.75]	3.23 [2.80, 3.68]	0.75	.460	0.09
Clarity					
Persons	4.44 [3.87, 4.98]	4.52 [3.84, 5.14]	0.22	.826	0.03
Locations	3.48 [3.19, 3.77]	2.95 [2.55, 3.31]	2.78	.011*	0.40
Objects	3.15 [2.82, 3.51]	2.75 [2.41, 3.14]	2.36	.028	0.28
Visual details	3.80 [3.46, 4.10]	3.48 [3.05, 3.96]	1.78	.089	0.20
Other sensory details	2.18 [1.87, 2.59]	2.35 [1.95, 2.83]	1.16	.258	0.10
Ease of remembering	3.24 [2.88, 3.63]	3.41 [2.99, 3.93]	0.71	.483	0.09
Emotional valence	0.73 [0.50, 0.97]	0.48 [0.27, 071]	1.91	.070	0.26
Emotional intensity	2.45 [2.05, 2.91]	1.76 [1.45, 2.23]	4.33	<.001*	0.40
Feeling of reexperiencing	2.96 [2.60, 3.35]	2.34 [2.65, 3.16]	1.93	.068	0.18
Feeling of mental time travel	2.82 [2.40, 3.28]	2.34 [1.83, 2.91]	2.20	.039	0.24
Rehearsal	0.20 [0.12, 0.32]	0.04 [0.00, 0.16]	2.97	.007*	0.37
Sharing	0.09 [0.04, 0.17]	0.00 [0.00, 0.04]	2.97	.007*	0.39

Note. * indicates differences that are significant after applying a correction for multiple comparisons using the Benjamini–Hochberg procedure (with a false discovery rate of .05).

differences in the phenomenological characteristics of imagined events were taken into account.

An unexpected finding was that future events that were unrelated to personal goals were imagined as involving more persons than goal-related events (note, however, that the difference was quite small—that is, less than one person). We do not have a ready-made explanation for this result and more research should be conducted to determine whether this is a reliable finding. Despite this difference in the content of imagined events, the recall of person components did not differ between the two types of events.

General discussion

The current research aimed to investigate the role of self-reference and personal goals on memory for future event simulations. We found that future events that involved the self were better recalled than events that involved an acquaintance (Experiment 1), and that future events that were related to personal goals were better recalled than future events that were unrelated to goals (Experiment 2). In both experiments, the manipulation of self or goal relevance impacted the phenomenological characteristics of future simulations (e.g., vividness and clarity of event components), but the enhanced recall of simulations remained significant when the effect of these characteristics were taken into account.

Taken together, the present experiments add to growing evidence that autobiographical information, and in particular personal goals, plays a key role in episodic future thinking (e.g., Anderson et al., 2015; Cole & Berntsen, 2016; D'Argembeau & Mathy, 2011; Demblon & D'Argembeau, 2014), and further suggest that future simulations are better memorized when they are integrated with autobiographical knowledge. To imagine future events, people flexibly recombine experiential details stored in memory under the guidance of schemas and general autobiographical knowledge (Addis, 2020; D'Argembeau, 2020; Schacter & Addis, 2007). Activation of autobiographical knowledge and the self-schema during this constructive process may promote the creation of links between newly imagined events and preexisting knowledge stored in memory (Conway, 2005; Klein, 2012; Symons & Johnson, 1997); indeed, self-representation may act as an integrative hub for information processing (Sui & Humphreys, 2015). As a consequence of these connections with autobiographical knowledge structures, self-related and goal-relevant future simulations may be better encoded, organized, and maintained in memory. Preserved traces of self-relevant and goal-relevant simulations may ultimately play a role in guiding decisions and actions, thus serving a pragmatic function (Baumeister et al., 2016; Bulley & Irish, 2018; Kvavilashvili & Rummel, 2020).

The reduced self-reference effect observed when future events involving the self were compared with future events involving a close other (Experiment 1) can also be interpreted according to the view that this effect primarily relates to the elaboration and organization of encoded information in memory (Klein & Loftus, 1988; Symons & Johnson, 1997). The self is admittedly the most elaborated knowledge structure stored in memory, but people also have extensive knowledge about intimate others, which can similarly be used to elaborate and organize future event simulations. Thus, the effects of self and other reference on memory for future simulations may depend on the extent to which imagined events can be integrated with preexisting knowledge (whether about the self or others), such that the memory advantage provided by self-reference is reduced as the amount of knowledge about the other person increases. Another related but somewhat different explanation would be that events involving close others benefit from self-referential processing. Indeed, it has been proposed that people's sense of self includes information about close others (Aron et al., 1991; Aron et al., 2004; Thomsen & Pillemer, 2017). Notably, in their *self-expansion model*, Aron et al. (2004) proposed that people are motivated to include close others in their representation of themselves in order to make their personal, material, and social resources (e.g., abilities, possessions, information, social networks) available for their own goal achievement. This inclusion of close others in the self may result in closely intertwined representations of autobiographical knowledge and information about close others in memory (Meyer et al., 2019).

The present experiments replicate previous studies showing that the content and phenomenological properties of future event simulations are influenced by their self and goal relevance (de Vito et al., 2012; Grysman et al., 2013; Lehner & D'Argembeau, 2016; Thomsen & Pillemer, 2017). More specifically, self-reference enhanced the global vividness of future simulations and the clarity of represented persons, while goal-relevance enhanced the vividness, clarity of persons and objects, and emotional intensity of events. Importantly, however, we found that the effect of self-relevance and personal goals on memories of the future persisted when these differences in the phenomenological characteristics of future simulations were taken into account. This suggests that the better memory for self-relevant and goal-relevant events is not simply due to the properties of mental simulations per se, but instead relies, as suggested above, on the integration of future simulations with preexisting autobiographical knowledge.

We also examined whether some categories of event components (i.e., locations, persons, objects, actions, and emotions) were better recalled than others, and explored whether this was influenced by the self and goal relevance of future simulations. In line with previous studies on memories of the future (Jeunehomme & D'Argembeau, 2017; McLelland et al., 2015; Szpunar et al., 2012), we found that locations and persons were among the best recalled event components. Being the core elements of spatial context, locations might be particularly well recalled in virtue of their essential role for the coherence of event representations (Hassabis & Maguire, 2007; Robin & Moscovitch, 2014; Wiebels et al., 2020). Once imagined (or recalled), spatial locations are then enriched by the integration of other elements (e.g., other persons and objects). Among those components, persons could be particularly well recalled because of their prominent role in creating causal connections (e.g., through actions) that link together the different components constituting event simulations (Radvansky & Zacks, 2014).

Beyond this general trend, self-reference and personal goals impacted memory for the constitutive components of future simulations. All future event components were better remembered for self-relevant events compared with events involving an acquaintance. This suggests that self-reference promotes memory not only for the general theme or gist of the imagined events, but also for their constitutive details. Again, this is consistent with the view that self-reference acts as an integrative hub, helping to bind different types of information (Sui & Humphreys, 2015; Symons & Johnson, 1997). On the other hand, the only event component that benefited from the link between future events and personal goals was emotion. Goal relevance is a critical determinant of emotion (Scherer & Moors, 2019), and emotion in turn plays an important role in guiding goal pursuit (Baumeister et al., 2016). Preserving emotional aspects of goal-relevant future simulations may thus be crucial for the motivational effects of memories of the future.

At first glance, our finding that locations were better recalled for future events that were unrelated to personal goals may seem surprising. In Experiment 2, the cue sentences that were used to imagine goal-unrelated future events were created based on materials initially developed to elicit mental representations of scenes (de Vito et al., 2012; Hassabis et al., 2007). Thus, a first explanation for our finding would be that these cue sentences promoted a richer representation of the spatial contexts in which future events would take place, leading to a better encoding and later retrieval of location components for goal-unrelated future events. This is unlikely to be the case, however, because the clarity of location was in fact rated as higher for goal-related than for goal-unrelated events during the imagination phase. Another possibility is that people organize goal-related and goal-unrelated future events in memory around different event components (Lancaster & Barsalou, 1997). It could be that goal-related future events are more often organized around persons, objects or actions because these elements are more relevant to goal pursuit. For example, if an individual's personal goals is to ask his girlfriend to marry him, he could imagine an event that takes place in a restaurant during which he will kneel down with a ring in his hand to propose to her. In this event, the person (i.e., *the girlfriend*), actions (i.e., *kneeling*, *giving the ring, and proposing to marry*), and the object (i.e., *the ring*) are undoubtedly more central and meaningful in the future event representation than the location where the event takes place (i.e., *a restaurant*). On the other hand, the location of events may be a more central aspect around which goal-irrelevant future scenarios are organized in memory because of the nature of the cues that were provided to participants (in which location was a prominent feature). This possibility is admittedly speculative, but could be investigated in future studies by asking participants to imagine goal-related and goal-unrelated future events in response to similar cues and to rate to what extent each event component is central to imagined scenarios.

In conclusion, the present research provides the first evidence that self-reference and personal goals enhance memory for future event simulations. Furthermore, our results show that the enhanced recall of self-relevant and goal-relevant simulations cannot be entirely explained by their effects on the characteristics (e.g., vividness) of simulations. Taken together, these findings suggest that imagined future scenarios are better preserved in long-term memory when they are integrated with preexisting autobiographical knowledge. An important avenue for future research will be to examine to what extent these memories of the future facilitate goal-directed behavior, as initially postulated by Ingvar (1985).

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