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Making the Future Memorable: The Phenomenology of Remembered Future Events

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Abstract

Although our ability to remember future simulations conveys an adaptive advantage, enabling us to better prepare for upcoming events, the factors influencing the memorability of future simulations are not clear. In this study, participants generated future simulations that combined specific people, places and objects from memory, and for each trial, made a series of phenomenological ratings about the event components and the simulation as a whole. Memory for simulations was later assessed using a cued-recall test. We used multi-level modelling to determine whether the phenomenological qualities of event components (familiarity, emotionality and significance) and simulations (detail, plausibility) were predictive of whether the simulation was successfully encoded and later accessible. Our results demonstrate that person familiarity, detail, and plausibility were significant predictors of whether a given future simulation was encoded into memory and later accessible. These findings suggest that scaffolding future simulations with pre-existing episodic memories is the path to a memorable future.

Keywords

episodic memory; future thinking; episodic simulation; hierarchical linear modelling; familiarity

Introduction

Imagination allows us to mentally simulate richly-detailed scenarios that are far removed from our present situation and enables us to prepare for upcoming events that have not yet occurred. Episodic simulation of future events has been a recent focus in memory research (Mullally & Maguire, 2013; Schacter et al., 2012) and one important issue that has arisen involves memory for such simulations; if imagined future events are to serve some adaptive purpose, it is critical that they are maintained in memory (Szpunar et al., 2013). Specifically, when a person imagines how they will deal with a particular situation, the simulation tends to be helpful to the extent that its details can be recalled when actually encountering the

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situation later on. While recent studies suggest that mental simulations evoking future-oriented processes are more likely to be successfully encoded than other simulations (Klein, Robertson, & Delton, 2010; Klein, Robertson, & Delton, 2011; Klein, Robertson, Delton, & Lax, 2012), not all future simulations are retained in memory (Szpunar et al., 2013). The factors determining which simulations become “memories of the future” (Ingvar, 1985) are not fully understood.

Familiarity may influence the memorability of future simulations. When participants judge the relevance of items in a list to a planned imagined future event, and are later given an unexpected recall test for those items, recall performance is significantly higher when the judgments are made in the context of a familiar (e.g. dinner party) versus an unfamiliar (e.g. Antarctica trip) future event (Klein et al., 2012). Klein and colleagues argued that when planning for familiar scenarios, participants had more episodic memories of similar occasions upon which to base their simulations, and evaluated each item with respect to these episodic memories. In contrast, when planning for unfamiliar scenarios, participants relied primarily on semantic representations. This interpretation is supported by findings that when participants imagine implausible events with which they have little experience, they tend to incorporate details not from episodic memory, but from external sources (Anderson, 2012).

Familiarity of event *components* has also been shown to affect the vividness of imagined future events. D’Argembeau and Van der Linden (2012) had participants imagine future events and rate the phenomenological characteristics of the simulation and its components, including the familiarity of the location, people and objects. When entered as predictors into a hierarchical linear model (HLM; Wright, 1998) the familiarity of event components significantly predicted future event vividness, suggesting that familiarity can determine how well the simulation can be pictured and imagined. However, whether or not familiarity also affects encoding of simulations is yet to be investigated.

Other phenomenological characteristics of imagined events, such as emotional valence and plausibility, can affect their quality and/or whether or not they are encoded. When participants imagine future events with either positive, neutral, or negative emotional valence and then later recall these events in a cued-recall test, participants recall significantly more emotional (i.e., positive or negative) simulations than neutral simulation after a ten minute delay, and they recall significantly more positive and neutral than negative future simulations after a one week delay (Szpunar, Addis, & Schacter, 2012). When emotional imagined future events are repeatedly simulated, participants rate the events as more plausible or likely to happen in real life than when the events are simulated only once (Szpunar & Schacter, 2013). Crucially, such increases in plausibility are also accompanied by corresponding increases in participant ratings of detail and ease of simulation. Since it has already been shown that the amount of detail in an imagined future event is related to whether it is later recalled (Martin et al., 2011), it is possible that plausibility is another factor that influences the retention of imagined future events in memory.

While these previous studies have demonstrated an influence of familiarity, detail, emotionality, and plausibility on the phenomenology of and/or the later memory for episodic simulations, it is not yet clear how these effects combine to exert their influence. Taken together, however, this research suggests that the vividness of a simulation may be key to whether that simulation will be remembered. Therefore, factors influencing the level of vivid detail might indirectly affect encoding. Although the familiarity of event components (e.g., people, places, and objects) has been shown to predict the vividness of the simulation (D'Argembeau & Van der Linden, 2012), it is possible that these effects on vividness may also improve subsequent retention of the simulation as a whole. It is also possible that the phenomenology of some event components may exert a greater influence on simulation vividness and encoding success than others. Moreover, while plausibility is likely to affect whether or not a simulation is encoded, it may be that this influence on retention is not significant over and above the effect of detail, given that more plausible simulations are typically also more detailed (Szpunar & Schacter, 2013).

We address these questions by systematically examining how the familiarity, emotionality, and personal significance of components comprising future simulations, as well as the detail and plausibility of the simulations themselves, simultaneously affect whether future simulations are retained in memory. To this end, we used HLM to assess whether these component and simulation characteristics significantly predict imagined event recall. HLM, a multilevel statistical approach, is arguably the most appropriate method for analyzing data with an inherently nested structure, and this technique is particularly useful for autobiographical memory research when memories or simulations are nested within individuals (Wright, 1998). Multiple memories or imagined events belonging to one participant will tend to be more similar to each other than they are to memories or events belonging to another person, and multilevel modelling corrects for biases in parameter estimates and the underestimation of standard errors that can result from this grouped and therefore potentially correlated nature of the data (Guo& Zhao, 2000). Furthermore, rather than losing rich trial-by-trial information by aggregating data into participant means, multilevel analyses allow us to directly test whether the phenomenology of an individual simulation can predict its mnemonic fate.

Methods

Participants

Twenty-one young adult participants (14 females, aged 18–35) provided written consent in this study approved by The University of Auckland Human Ethics Committee. They were all right-handed, fluent in English and did not suffer from neurological or psychiatric conditions.

Procedure

We used an adapted version of the experimental recombination task (Addis, Pan, Vu, Laiser, & Schacter, 2009; Martin et al., 2011; see Figure 1). In session 1, participants described 110 personal episodic events from the past 10 years, identifying a unique main *person*, *location*, and *object* that featured in each event and rating each of these components for *familiarity* (how well a particular detail was known), *emotionality* (the intensity of emotion elicited by the detail), and *personal significance* (how important the detail is within the participant's life) on 4-point scales (0 = low, 3 = high). These details were then randomly rearranged into new combinations. Approximately one week later, in session 2, participants were shown 90 recombined sets of the person, location, and object details and for each set. For each, they had 8 s in which to imagine a specific future event that might occur in the next five years, integrating themselves and all three details into the scenario. Note that this 8 second time limit has been shown to be sufficient for the construction of future simulations; RT data from previous studies using this experimental recombination paradigm (e.g., van Mulukom, Schacter, Corballis and Addis, 2013) indicate that on average it takes 4.37 s to construct a future simulation from personalized stimuli and that participants are successful at doing so within this time limit on 95% of trials. Following construction, participants then rated the simulation for *detail* (how vivid the simulation was) and *plausibility* (the degree to which the participant felt this event was possible given their personal circumstances) on a 4-point scale (0 = low, 3 = high; 4 s each). Ten minutes following session 2, participants completed an unexpected cued-recall test. They were shown two details from each imagined event and asked to recall the missing detail. The particular detail tested (person, location, or object) was randomly-ordered and counterbalanced. Based on responses on this test, each imagined event from session 2 was classified as either successfully or unsuccessfully encoded. Specifically, only events for which the correct detail was recalled were considered successfully encoded. Events in which a detail from another event or a completely erroneous detail was recalled were classified as instances of unsuccessful encoding.

HLM

Using HLM 7 software (Raudenbush, Bryk, & Congdon, 2011), two-level random coefficient models were created in which each imagined event was modelled at the lower level and each participant at the higher level, resulting in 1828 records at level one and 21 records at level two. Depending on the model being constructed, the level one predictors could include: mean-centred ratings of familiarity, emotionality, and significance for the event components (either separately for the person, place, and object details or averaged across the event components), and ratings of detail and plausibility for the simulation. All variable slopes and intercepts were allowed to vary across participants. Recall success (a binary outcome) required a logistic link function restricting predicted values to fall between 0 and 1 (Guo & Zhao, 2000). The unit-specific models were estimated using a high-order Laplace approximation of maximum likelihood with 20 iterations (Raudenbush, Yang, & Yosef, 2000).

Results

Cued-recall performance

Participants recalled an average of 55% (SD = .16, SE = .04) of their future simulations. A repeated-measures ANOVA illustrated a significant effect of missing detail type, $F(2,40)$ = 14.62, $p < .001$. When asked to recall the person (M = .64, SD = .19, SE = .04, $p < .001$) or location (M = .55, SD = .19, SE = .04, p = .02), participants remembered a significantly higher proportion of simulations than when asked to recall the object (M = .46, SD = .19, SE = .04). Moreover, the proportion remembered was higher when recalling the person relative to the location (p = .04).

Simulation phenomenology

To examine whether mean ratings differed across event components, a repeated-measures ANOVA with factors of event component (person, place, object) and rating type (emotionality, familiarity, significance) was applied, and a Greenhouse-Geisser correction used when sphericity assumptions were violated. There was a significant main effect of event component, $F(2,40) = 28.78$, $p < .001$ and Bonferroni-corrected pairwise comparisons indicated that the person component was rated significantly higher across all dimensions than both the location ($p < .001$) and object ($p < .001$). The location component was rated significantly higher than the object ($p = .011$; see Figure 2). The main effect of rating type, $F(1.26,25.22) = 17.94$, $p < .001$, reflected significantly higher ratings on the familiarity scale than the emotionality ($p = .001$) and significance ($p < .001$) scales. Mean emotionality and significance ratings did not differ ($p = 1.0$). The event component by rating type interaction was not significant, $F(2.21,44.14) = 1.85$, $p = .166$.

Predictors of later recall for a future simulation

An initial intercept-only HLM model showed that a significant portion of the variance in simulation recall performance was due to between-participant variation, $\tau(20) = 0.456$, $p < .001$, explaining 12.2% of the variance, indicating that multi-level modelling was more appropriate than single-level analyses. We next examined whether the model fit was improved relative to the intercept-only model when ratings of mean familiarity, emotionality, and significance (averaged across event components), were added as level-1 predictors of recall. This new model significantly reduced the deviance statistic (reflecting improved model fit) relative to the intercept-only model (likelihood-ratio test; $\xi^2(12) = 60.91$, $p < .001$). Mean familiarity significantly predicted simulation recall, $t(20) = 3.73$, $p = .001$, odds ratio (*OR*) = 1.58. Mean emotionality ($t(20) = .23$, $p = .821$, *OR* = 1.05) and mean significance ($t(20) = 1.51$, $p = .148$, *OR* = 1.41) did not significantly predict variance in recall over and above that predicted by mean familiarity[1].

Given that mean familiarity influenced recall, we investigated how the familiarity of individual event components contributed to this effect. Person, location, and object familiarity were entered as level-1 predictors into a new model of imagined event recall. This model revealed that while person ($t(20) = 5.60$, $p < .001$, *OR* = 1.58) and location familiarity ($t(20) = 3.03$, $p = .007$, *OR* = 1.20) both significantly predicted recall, object familiarity ($t(20) = 1.47$, $p = .157$, *OR* = 1.09) did not.

We then examined whether the phenomenology of the simulation as a whole could predict later recall of that simulation. This third model showed that both the detail and plausibility of the simulation significantly predicted recall when entered simultaneously. Adding the previously-significant person familiarity as a third predictor improved the model fit ($\xi^2(5) = 21.65$, $p < .001$), while adding location familiarity ($\xi^2(6) = 8.46$, $p = .205$) as a fourth did

[1]Mean component familiarity ratings also significantly predicted the amount of detail in the simulation (β=0.237; SE=.054; $t(20) = 4.36$, $p < .001$), replicating the effect demonstrated by D'Argembeau and Van der Linden, 2012), while mean emotionality (β=.092; SE=.093; $t(20) = .99$, $p = .334$) and mean significance (β=0.019; SE=0.068; $t(20) = .28$, $p = .78$) did not significantly predict simulation detail.

not[2]. Therefore, the most parsimonious model of simulation recall included person familiarity, detail, and plausibility (see Table 1 for model coefficients and statistics).

Predictors of later recall for specific event components

Finally, we examined (1) whether familiarity ratings for the two event components used as cues in the recall test would predict memory for the missing component, and (2) whether the familiarity of the missing component would predict its own memorability. Three new models were created for this analysis: one for each type of detail to be recalled. Person, location, and object familiarity were entered as predictors into each model. Person ($t(20) = 2.20$, $p = .040$) and location familiarity ($t(20) = 2.55$, $p = .020$) were significant predictors of object recall, while object familiarity was not ($t(20) = .685$, $p = .501$). Person familiarity ($t(20) = 3.88$, $p < .001$) significantly predicted location recall, but location ($t(20) = 1.72$, $p = .101$) and object familiarity ($t(20) = .072$, $p = .943$) did not. Finally, person ($t(20) = 5.15$, $p < .001$) and object familiarity ($t(20) = 2.30$, $p = .033$) were significant predictors of person recall, while location familiarity ($t(20) = .072$, $p = .943$) was not.

Discussion

We examined how the phenomenological characteristics of the components comprising a future simulation as well as the quality of the simulation as a whole combine to influence the memorability of the simulations. Our results further support the notion that the amount of detail comprising a simulation influences its later recall, but suggest that event plausibility is also important. Additionally, we show that it is not just the phenomenology of the simulation as a whole that is important to the retention of simulations, but also the phenomenology of the components comprising the simulation. While we expected that simulations involving more familiar, significant, and emotional components would be more memorable, only person familiarity emerged as a key predictor of subsequent memory.

We expanded on previous findings that simulations comprising more familiar components are rated as more detailed (D'Argembeau& Van der Linden, 2012) by showing that, in line with our predictions, more detailed simulations were more memorable. This effect is consistent with a previous finding that later-remembered future simulations are significantly more detailed than later-forgotten ones (Martin et al., 2011). Even so, the nature of the interaction between the generation of episodic detail and encoding the event into memory is not entirely clear. High correlations are found between the constructs of detail and encoding in autobiographical memory, but the fact that this association is modulated by the age, rehearsal frequency, and emotional content of the memories suggests that detail and encoding are separable processes (Ritchie, Skowronski, Walker, & Wood, 2006). The incorporation of more episodic details into the simulation may result in the event being more integrated with existing episodic knowledge and thus more accessible during the cued-recall test. Poppenk and Norman (2012) propose that during encoding, retrieving related

[2]Model coefficients and statistics for the significant model are provided in Table 1; for completeness, the coefficient and statistics for this non-significant model are: Intercept (SE=0.177; $t(20)=1.289$, $p=0.212$; *OR*=1.256); Detail (β= 0.738; SE=0.102; $t(20)=7.256$, $p<.001$; *OR*=2.091); Plausibility (β=0.297; SE=0.076; $t(20)=3.924$, $p<.001$; *OR*=1.345); Person Familiarity (β= 0.295; SE=0.078; $t(20)=3.768$, $p=.001$; *OR*=1.343); and Location Familiarity (β=0.143; SE=0.067; $t(20)=2.312$, $p=.046$; *OR*=1.154).

information can facilitate the binding of the new information into memory, helping these new representations to “stick”. Therefore, more detailed simulations comprising greater amounts of information from episodic memory are more likely to be scaffolded in this way, increasingly the likelihood of later retrieval.

The plausibility of the simulation also predicted later recall. An important distinction to be made is whether plausibility is determined with reference to the likelihood that event could occur to people in general (i.e., “general plausibility”) or with reference to one’s own personal life circumstances (i.e., “personal plausibility”; for more discussion, see Cole, Fotopoulou, Oddy and Moulin, 2014; Scoboria, Massoni, Kirsch and Relyea, 2004). Although previous studies examining the effect of plausibility on imagined event phenomenology have found inconsistent results, it may be that only personal plausibility is relevant, and perhaps only when a simulation involves familiar components. Anderson (2012) found that the plausibility of scenarios with which one was generally unfamiliar (e.g., a trip to outer space) did not influence ease of simulation, whereas Szpunar and Schacter (2013), using a similar recombination paradigm to the present study, found that increases in personal plausibility were accompanied by increases in the ease of simulation and the amount of detail generated. Similarly, D’Argembeau and Van der Linden (2012) reported that more vivid simulations are associated with increases in ratings of subjective likelihood. Our findings regarding personal plausibility expand on those of Szpunar and Schacter(2013) and D’Argembeau and Van der Linden (2012) by showing that the influence of personal plausibility on the phenomenology of simulations extends to their recall. This effect of personal plausibility on recall may operate *via* its demonstrated influence on phenomenology. Moreover, it may be that inclusion of familiar event components makes a simulation feel more plausible. Nonetheless, it is notable here that plausibility was a significant predictor over and above detail and familiarity, and likely exerts some independent influence on whether a simulation is successfully encoded.

We also investigated whether the phenomenology of the particular components comprising a simulation could influence the mnemonic fate of that simulation. In contrast to our prediction that simulations involving more familiar, personally significant, and emotional components would result in more memorable simulations, familiarity was the *only* phenomenological marker of event components that predicted subsequent memory. The influence of familiarity on subsequent memory is in line with previous research demonstrating that familiarity affects the memorability of imagined events (Klein et al., 2012; Poppenk, Kohler, & Moscovitch, 2010; Poppenk, McIntosh, Craik, & Moscovitch, 2010). Here we demonstrate that the familiarity of particular components, namely the persons comprising the simulation, appears to be crucial. Even in the final model that included the detail and plausibility of the simulation, person familiarity was still a significant predictor of subsequent memory performance. Moreover, the familiarity of the person component was important for recall performance irrespective of which particular component had to be remembered on the cued-recall test. The inclusion of either a familiar person or location in the imagined event tended to enhance recall regardless of which detail type was missing. However, person familiarity predicted recall for the person, location, object event details, as well as the likelihood of recall in general, and the person was also the most likely of the three event components to be recalled. This finding is consistent with our prediction that the most integral parts of simulation – such as people rather than objects – are most likely to influence later memory.

This importance of the person detail contrasts with a previous focus on the importance of the familiarity of an imagined event's location on its phenomenological characteristics (Arnold et al., 2011; Szpunar et al., 2009). Indeed, we had hypothesized that the familiarity of locations along with people would be predictive of later recall. Although location familiarity significantly predicted event recall in the present study, it did not explain any variance in recall beyond that explained by person familiarity, detail, and plausibility. Interestingly, person details were rated as significantly more familiar, emotional, and personally significant than locations and objects, suggesting that participants had richer representations of the people than they did the other components. Therefore, it is possible that having any highly familiar detail in the scenario means that event and its components are more likely to be recalled. Further research is needed to determine if this is the case.

While the exact mechanism by which person familiarity enhances event recall remains unknown, findings from previous research and our current results show that the familiarity of event components does predict the vividness of the simulation (D'Argembeau & Van der Linden, 2012), which in turn can influence whether it will be later recalled (Martin et al., 2011). Indeed, we found that familiarity was the only significant predictor of vividness, while the other qualities of event components such as emotionality and personal significance were not informative. However, our results indicate that person familiarity predicted later recall over and above what was predicted by the detail of the simulation as a whole, indicating that the effect of familiarity is not entirely explained by its tendency to increase the amount of vivid detail in an imagined event. Another possibility may relate to the fact that familiar people are more heavily tied to past experiences, and novel associations between a new simulation and previous experiences may aid later recollection. Bar (2009) proposes that encoding occurs when scenarios deviate from expectations accumulated with experience. When participants are tested on their ability to recall a series of past autobiographical events, those events involving behaviours that were atypical or unusual for the person in the event are better recalled than events involving behaviours that were typical of the person or neutral (Skowronski, Betz, Thompson, & Shannon, 1991). The expectation-violation that results from our paradigm in which highly familiar components are randomly rearranged into new combinations may therefore enhance encoding, particularly for novel simulations involving a familiar person.

In summary, imagined future events that are simultaneously more detailed, more plausible, and comprised of more familiar elements have a higher likelihood of being recalled later in a cued-recall test compared with imagined events that are less detailed, plausible, and familiar. The familiarity of the person featured in the event was a better predictor of simulation recall than the familiarity of the location and object, which may reflect in part the person being more familiar than the other details. Simulations high in detail, plausibility and person familiarity likely have strong associations to past episodic experiences. Therefore, it might be that "scaffolding" (Poppenk & Norman, 2012) future simulations with pre-existing episodic knowledge is the path to a memorable future.

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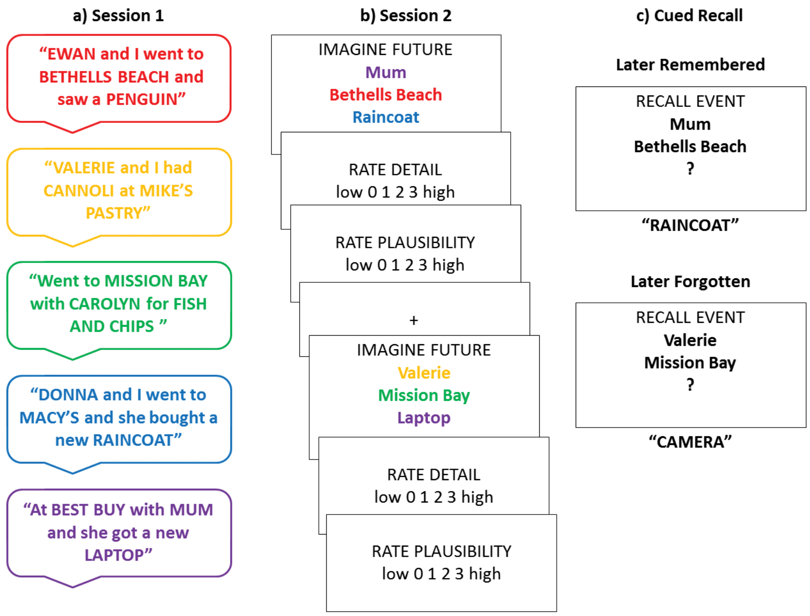

Figure 1.

A schematic diagram of example details collected during session 1 (a), recombined details presented during session 2 to elicit future simulations (b), and the cued-recall memory test (c).

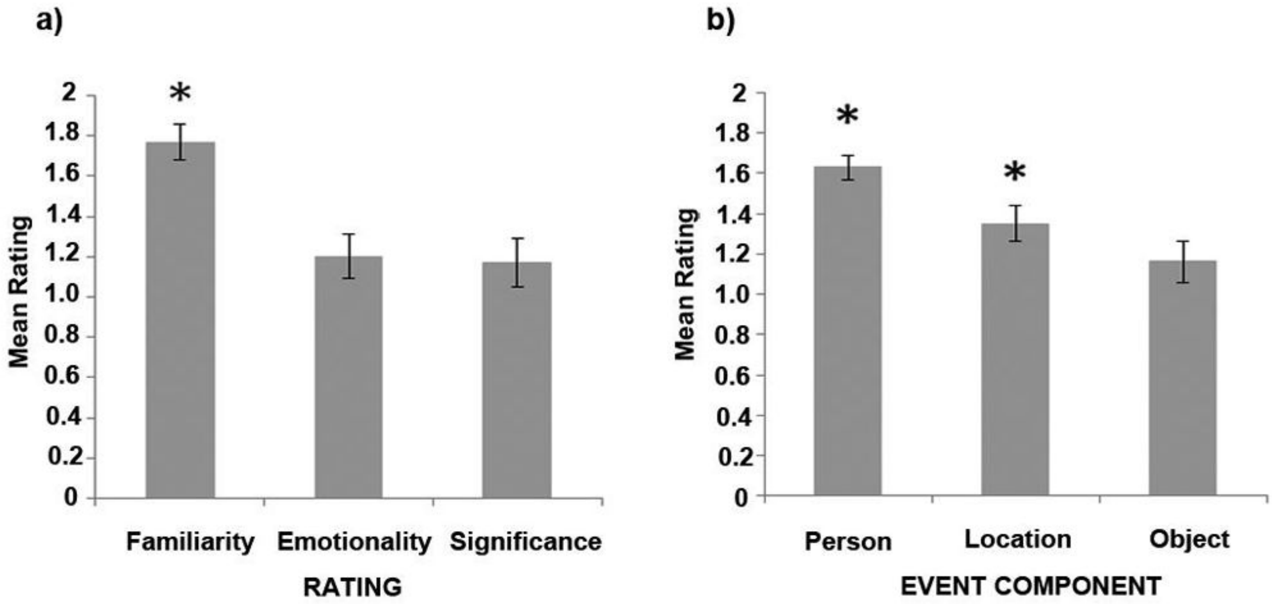

Figure 2.
Mean participant ratings for (a) familiarity, emotionality and significance (averaged across event components), and b) person, location and object components (averaged across rating type). Note that these ratings were made on a four point scale (0=low, 3=high). Error bars reflect standard error of the mean. * Significantly different from other means, $p < .05$.

Table 1

Coefficients and statistics for multilevel model of simulation recall

Fixed Effect	Coefficient	*SE*	*t*-ratio	*d.f.*	*p*	O.R.	C.I.
Intercept	-	0.179	1.281	20	.215	1.257	(0.866, 1.825)
Detail	0.759	0.097	7.808	20	<.001	2.136	(1.744, 2.616)
Plausibility	0.298	0.076	3.934	20	<.001	1.347	(1.150, 1.578)
Person Familiarity	0.298	0.076	3.898	20	<.001	1.347	(1.148, 1.579)

Note. *SE* = standard error, *d.f.* = degrees of freedom, O.R. = odds ratio, C.I. = confidence interval