Running title: Belief in future occurrence

The predictive validity of belief in future occurrence

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Abstract

Prospection is associated, in varying degrees, with a sense that imagined events will (or will not) happen in the future—referred to as *belief in future occurrence.* The present research investigated to what extent this belief is justified and predicts the actual occurrence of events in the future. In two studies, participants rated their belief in the future occurrence of events imagined to happen in the coming month (Study 1) or week (Study 2), and the actual occurrence of events was then assessed. Results showed that the odds of event occurrence were about 2 times higher with an increase of 1 unit on the belief scale. Belief was particularly pronounced for temporally close events and was largely determined by the congruence of events with autobiographical knowledge. These results suggest that belief in future occurrence has some truth value and may inform decisions and actions.

Keywords: episodic future thinking; prospection; belief in occurrence; autobiographical memory; temporal distance

The future is fundamentally uncertain—we know all too well that things do not always go as planned—and yet we do not always think and behave with this uncertainty in mind. Our daily life activities are guided by mental maps of the future that portray events we believe will actually materialize: things we need to do later in the day, plans for the weekend, an appointment at the doctor's, a conference next month, the wedding of our friend next summer, and so forth. If prompted, we can of course ponder the uncertainty of expected events, but most of the time we take them for granted—we make decisions and act as if they were "real". The primary goal of this research is to investigate the extent to which such belief in future occurrence is warranted.

The ability to simulate possible futures and to organize actions accordingly is a central feature of the human mind—our behavior is not entirely determined by present circumstances but is guided by anticipations of what might lie ahead (Baumeister et al., 2016; Schacter, 2012; Suddendorf & Corballis, 2007; Tulving, 2005). The mechanisms of prospection are increasingly well understood, with evidence pointing to the key roles of episodic and semantic memory in the capacity to imagine future events (for a recent review, see Schacter et al., 2017). Patients with memory deficits have difficulties imagining future scenarios (e.g., Addis et al., 2009; Hassabis et al., 2007; Irish et al., 2012), and functional neuroimaging evidence shows that episodic and semantic memory networks are activated when healthy individuals imagine future events (Benoit & Schacter, 2015; Binder & Desai, 2011). These and other findings suggest that episodic and semantic memory representations provide the sources of information—details from prior experiences and general event knowledge—that are used for imagining future events (Irish & Piguet, 2013; Schacter & Addis, 2007; Szpunar, 2010).

The construction of novel event representations based on memory contents is clearly an important ingredient of prospection, but this constructive process is in fact involved in the imagination of any kind of events, whether or not they refer to future happenings (Addis,

2018; Mullally & Maguire, 2014; Schacter et al., 2012). An important question then is what makes us believe that an imagined event refers to something that might happen in our personal future? This belief might arise from attributions that we make about mental representations of events, in a similar way as the experience of remembering results from attributional processes (Johnson, 2006; Johnson et al., 1993; Rubin, 2006).

An elegant series of studies by Alan Scoboria and his colleagues have demonstrated that the belief that an event genuinely occurred in the past results from specific metamemory appraisals and needs to be distinguished from recollection (i.e., the sense of re-experiencing the past; Scoboria et al., 2014, 2015). This distinction between belief in occurrence and recollection is most apparent in the phenomenon of non-believed memories, in which autobiographical events are no longer believed to have happened even though vivid recollective features remain present (Mazzoni et al., 2010; Otgaar et al., 2014). Belief in occurrence results from the summative appraisal of sources of information available at the time an event is remembered and is notably modulated by event plausibility and social feedback (Scoboria et al., 2017). Even for memories that are associated with high levels of belief in occurrence, ratings of belief and recollection form distinct latent constructs that are predicted by different variables (e.g., belief in occurrence: event plausibility, rehearsal, links to other events; recollection: perceptual details and emotion; Scoboria et al., 2014, 2015). Belief in occurrence has also been distinguished from belief in accuracy, which reflects appraisals of the correspondence between represented contents and what was experienced at the time of the event (Scoboria & Pascal, 2016).

The kind of attributional processes that shape belief in occurrence may also operate when thinking about future events. Of course, beliefs in the occurrence of past and future events differ in epistemic status, as the past has happened whereas the future has yet to come (Perrin, 2016). Nevertheless, recent studies have shown that future-oriented thoughts are

associated, in varying degrees, with a subjective sense that the imagined events will (or will not) materialize in the future—referred to as *belief in future occurrence* (Ernst et al., 2019; Ernst & D'Argembeau, 2017; Scoboria et al., 2020; see also Mahr, 2020, for further discussion of the dimension of factuality of episodic simulations). Although belief in future occurrence can be based on systematic likelihood judgments, it need not be the case and most of the time it may arise from implicit or heuristic processes, such that the sense of "realness" of imagined events is directly given to experience (in fact, a systematic evaluation of likelihood may mainly occur when envisioned events feel uncertain). As such, belief in future occurrence may be conceived as a cognitive feeling—a subjective experience that indicates the status of one's knowledge or expectations (Clore & Parrott, 1994; Schwarz, 2012)—that conveys a sense of personal "truth" or subjective veridicality to imagined events, which can then inform judgments, decision making, and behavior.[1]

Belief in future occurrence reflects metacognitive appraisals based on phenomenological experience, the information available when future events are imagined, and other relevant knowledge (Scoboria et al., 2020). Most notably, research has shown that for an imagined event to be experienced as a possible future occurrence, it has to be consistent with broader autobiographical knowledge. Qualitative analyses of the reasons provided to justify belief in future occurrence indicate that people most frequently refer to personal goals, personal characteristics, and other personal events to explain their sense that imagined events will (or will not) happen in the future (Ernst et al., 2019; Ernst & D'Argembeau, 2017). Furthermore, variations in the strength of belief in future occurrence across imagined events

[1] A conceptual issue that deserves clarification is the relation between belief in future occurrence and other constructs that have been developed in understanding how intentions, goals, and plans predict behavior (Milyavskaya & Werner, 2018; Sheeran, 2002). Notably, the theory of planned behavior relies on the concept of behavioral belief, which is defined as the "subjective probability that performing a behavior of interest will lead to a certain outcome or involve a certain experience" (Ajzen & Kruglanski, 2019, p. 775). While related, the notion of belief in future occurrence, as conceived here, encompasses a broader range of events: it can be applied to any future event, whether or not it involves a behavioral intention.

(as assessed by rating scales) are predicted by the personal plausibility of events and the extent to which they are integrated in an autobiographical context (Ernst et al., 2019; Ernst & D'Argembeau, 2017; Scoboria et al., 2020). Besides autobiographical knowledge, other factors such as mental imagery (Koehler, 1991), ease of imagination (Kahneman & Tversky, 1982), and repetition (Szpunar & Schacter, 2013) may also modulate subjective beliefs about what will take place in the future.

While these studies indicate that belief in future occurrence is an important dimension of future-oriented thought, the extent to which such belief predicts the actual occurrence of events in the future is unknown. There is evidence that the majority of events that people foresee actually occur, but of course expectations are not perfect and some imagined events never materialize. Studies investigating the completion of intentions in daily life found that around 75% of activities that people had planned for the coming week were actually accomplished (Marsh et al., 1998; see also Sheeran, 2002, for a review of studies on the relations between intention and behavior). A study that included a broader variety of future events (i.e., not only intentions and plans, but any specific event that might happen) found that 61% of events that were imagined to occur within one year actually happened (Spreng & Levine, 2013). Given imperfect rates of occurrence of imagined events, the ability to identify mental scenarios that are most likely to materialize would be much useful for effectively guiding decisions and actions. Previous studies have shown that people's belief in the occurrence of past events shapes their attitudes and behavior (e.g., Bernstein et al., 2015; Wang et al., 2017, 2019). By providing information on the truthfulness of imagined events, belief in future occurrence may serve a similar directive function.

The primary goal of the present research was to test this hypothesis by examining whether variations in belief in occurrence across imagined events predict the actual occurrence of events in the future. If belief in future occurrence acts as a cognitive feeling that

guides decisions and daily life activities, then one would expect that belief ratings would predict the actual occurrence of imagined events. Here we assessed the predictive validity of belief in future occurrence in two studies in which participants were asked to imagine events that might happen in the coming month (Study 1) or week (Study 2).

Study 1

The first aim of Study 1 was to determine whether the measure of belief in future occurrence developed by Scoboria et al. (2020) predicts the actual occurrence of events imagined to happen in the coming month. In addition, we also aimed to identify characteristics of mental representations that determine belief in future occurrence. Multiple factors contribute to the subjective sense that an imagined event will or will not happen in the future. As noted above, belief in future occurrence is higher when imagined events are consistent with autobiographical knowledge, and the subjective quality and repetition of imagination also modulate degrees of belief (Ernst et al., 2019; Ernst & D'Argembeau, 2017; Scoboria et al., 2020). Our aim was to investigate the respective contribution of these factors to the overall sense of future occurrence. Based on the above mentioned studies, we expected belief in future occurrence to be predicted by (1) the integration of events with autobiographical knowledge (as indicated by their personal importance and links to goals and plans), (2) the quality of mental representations (sensory-contextual details, ease of imagination), and (3) previous thoughts and experience with the imagined events. In addition to these three main dimensions of interest, we also included a few other scales to explore other dimensions that might influence belief in future occurrence (e.g., emotion, sense of personal control), but we did not have strong hypotheses about these variables. Finally, in addition to examining the predictive validity of belief in future occurrence, we also explored whether belief in accuracy (i.e., the extent to which one believes that the content of the represented event corresponds to

how the event will happen; see Scoboria & Pascal, 2016) also has some predictive value (i.e., predicts the extent to which the event unfolded in the way one imagined it would).

Method

Participants. A total of 40 participants were initially tested, but two of them did not come to the second testing session; the final sample included 20 women and 18 men, aged between 18 and 30 years (M = 24.5, SD = 2.5). An a priori power analysis for linear multilevel regression models (predicting belief in occurrence) using MLPowSim (Browne et al., 2009) indicated that a sample size of 10 events (level 1) and 40 participants (level 2) provided a statistical power above 90% to detect a medium effect size (beta = 0.30) for fixed effects. Furthermore, an a priori power analysis for logistic multilevel regression models (predicting the actual occurrence of events) (Olvera Astivia et al., 2019) indicated that this sample size provided a statistical power of 82%, with a medium effect size (beta = 0.30). All participants gave written informed consent and the study was approved by the Ethics Committee of the Faculty of Psychology of the University of Liège.

Materials and Procedure. The study involved two testing sessions that took place a month apart. During the first session, participants were asked to produce 10 events that might occur in the coming month. It was specified that the selected events could be related to any life domain (e.g., work, relationships, leisure activities, and so on) and could be either events that were planned or events that were not planned but could reasonably happen. It was also mentioned that the events should be specific (i.e., events happening at a specific time and place and lasting no longer than a day), and an example was given to illustrate what would be considered as a specific or non-specific event (a weekend getaway in the country is not a

sufficiently specific event because it happens over several days, but imagining taking a walk in the forest during this weekend is a specific event). Thus, the instructions allowed participants to produce a variety of future events, provided that they were specific.

After the 10 events had been produced, participants were asked to imagine each event in as much detail as possible and to rate various characteristics of their mental representation while keeping the event in mind. Ratings were made on a series of 7-point Likert scales selected from previous studies on episodic future thinking (D'Argembeau & Van der Linden, 2012; Ernst & D'Argembeau, 2017). Belief in future occurrence was assessed using the four items with the highest loadings on the scale developed by Scoboria et al. (2020) (Cronbach's alpha = 0.94 in the current sample).[2] The subjective quality of mental imagery was assessed with four items (amount of sensory details: 1 = not at all, 7 = a lot; clarity of location: 1 = not at all, 7 = very clear; sense of experiencing the event: 1 = not at all, 7 = very strong; feeling of mental time travel into the future: 1 = not at all, 7 = totally; Cronbach's alpha = 0.84), and another item assessed the ease of imagination (1 = very difficult, 7 = very easy). The integration of the imagined event in an autobiographical context was assessed using three items: personal importance (1 = not at all important, 7 = very important), links to personal goals (1 = not at all, 7 = totally), and whether the event had already been planned (1 = not at all, 7 = totally); these items were analyzed separately because they were only moderately correlated to each other. Participants also indicated whether they had already thought about the imagined event on a previous occasion (1 = not at all, 7 = very often), and whether they had already experienced a similar event in the past (1 = not at all, 7 = very often).

Besides these ratings that were of primary interest for our purpose, we also included a few other rating scales to explore other dimensions that might influence belief in future

[2] Although the belief in occurrence scale includes 8 items, it was initially designed to allow the use of a short form; here we used the 4 items with highest loadings to stay consistent with our previous work on the determinants of belief in future occurrence (Ernst et al., 2019).

occurrence. Three items assessed how much control (1 = not at all, 7 = total) participants assigned to themselves, other people, and circumstances in the occurrence of the event (Merck et al., 2016; Roseman et al., 1990). One item assessed the familiarity of the imagined location (1 = not at all, 7 = very familiar). Two items assessed emotional responses while imagining and anticipated emotions if the event occurs (from -3 = very negative, to +3 = very positive; 0 = neutral); these two items were strongly correlated in the present study and were averaged. Finally, one item assessed belief in accuracy (i.e., the belief that the event will take place exactly in the way one imagines it; 1 = not at all, 7 = very strong) (Ernst & D'Argembeau, 2017). Participants also estimated the date when the imagined event would happen.

One month after the first session, participants received a description of the 10 events they provided a month ago. For each event, they were asked whether or not they remembered describing this event during the first session, and whether or not the event occurred during the past month. If the event happened, they had to report the date of the event, and they rated the extent to which the event unfolded as they imagined (1 = not at all, 7 = completely), as well as their emotion during the event (from -3 = very negative, to +3 = very positive; 0 = neutral). If the event did not occur, they were asked to specify whether the event was abandoned, reported or forgotten; and whether the event did not occur because of internal (e.g., motivation) or external (e.g., circumstances) factors. The instructions and rating scales that were used in this study are available on OSF (https://osf.io/shfyz/).

Scoring of event content. To give an idea of the thematic content of the reported events, we classified them in broad categories of life events: work or school-related activities (e.g., studying in the cafeteria, presenting a clinical case at work), social activities (e.g., going to the restaurant with my friends, celebrating my cousin's birthday), leisure activities (e.g., taking my dog for a walk in the woods, playing the accordion), domestic and daily activities (e.g.,

driving my son to the football club, repairing the sink), and health-related activities (e.g., doing my physical therapy session, going to the dermatologist). All events were scored by a trained rater and a random selection of 20% of events were independently scored by a second rater to assess inter-rater reliability. Inter-rater agreement was almost perfect, with Cohen's Kappa = .98.

Statistical analyses. The bivariate relationships between belief in future occurrence and other event characteristics were examined by fitting a series of linear multilevel regression models (two-level random intercept models, with events as level 1 units and participants as level 2 units; Hox, 2010), with ratings on the belief scale as outcome variable and each measure of interest as predictor. The continuous predictors were centered around each subject's own mean (cluster-mean centering) to obtain an unbiased estimate of the within-subject association between the predictor and the outcome (Brauer & Curtin, 2018). For event characteristics that were significantly related to belief in occurrence, we also investigated the unique contribution of each characteristic to the prediction of belief. To do so, we started by fitting a multilevel model that included measures of the properties of mental representations (i.e., subjective quality of mental imagery and ease of imagination), and then we progressively added other variables measuring autobiographical context, previous thoughts, and so on. At each step, the extent to which adding the fixed effects of the corresponding variables provided a better fit to the data was assessed using model comparisons (Hox, 2010). Improvements in model fit were evaluated using -2 times the change in log-likelihood, which is distributed as χ^2 with degrees of freedom equal to the number of parameters added. Finally, to investigate the extent to which belief in future occurrence predicted the actual occurrence of events, we fitted a multilevel logistic regression model with actual occurrence as outcome and belief in occurrence as predictor.

All analyses were conducted in R using the lme4 package (Bates et al., 2015) and parameters were tested for significance with the lmerTest package (Kuznetsova et al., 2017). The full random structure (i.e., by-subject random intercepts and random slopes) was included in the models; when the model failed to converge or led to a singular fit, the random effect correlations or the random slopes were removed. The impact of violations of model assumptions (e.g., normality of residuals) was investigated by conducting the same analyses with robust methods (Field & Wilcox, 2017), using the robustlmm package (Koller, 2016). The two models led to consistent results for most analyses, but when they deviated then the robust model is reported. Graphical representations of effects were made using the effects package (Fox & Hong, 2009). The data and analysis scripts of this study are available on OSF (https://osf.io/shfyz/).

Results

Of the 380 future events that participants reported, 253 actually happened (67%).[3] For events that occurred, participants reported that the events unfolded pretty much as they had imagined (M = 4.88, SD = 1.74). Of the 127 events that did not happen, 66 were postponed (52%), 42 were abandoned (33%), and 19 were forgotten (15%); participants reported that most events did not occur because of internal rather than external factors (63% vs. 37% of events, respectively). In terms of thematic content, the reported events involved social activities (37% of events), work or school-related activities (19% of events), leisure activities (24% of events), domestic and daily activities (17% of events), and health-related activities (3% of

[3] Participants remembered having produced the event during the first session for 91% of events, but all events were included in the following analyses because participants could tell whether or not the event occurred even for events that they did not remember producing.

events). There was no clear relation between thematic content and event occurrence (see Supplemental Materials).

During the first session, participants were able to provide an estimate of the date for 229 events (60%); for other events, participants provided a date bracket rather than an exact date. The mean temporal distance of events for which an exact date was provided was 7.68 days (*SD* = 7.78; range: 0-31). For events that occurred and for which participants provided an exact date, the mean temporal distance between the predicted and actual date was 1.69 days (*SD* = 4.22, range: 0-24).

Determinants of belief in future occurrence. Descriptive statistics for belief in future occurrence and other measures are presented in Table 1. To identify event characteristics that predict belief in future occurrence, we first examined the bivariate relationships between the belief scale and other measures by fitting a series of linear multilevel regression models with the belief scale as dependent variable and each measure of interest as predictor (see Method). The ICC for belief in occurrence was 0.12, showing that most variance in belief (88%) was due to differences between events within participants rather than differences between participants. As shown in Table 2, belief in future occurrence was related to the quality of mental imagery, ease of imagination, autobiographical context of events (importance and relations to goals and plans), their familiarity (previous thoughts and similarity to past events), and emotional valence.

Next, we investigated the specific contribution of event characteristics to the prediction of belief in future occurrence using model comparisons (see Method). First, we fitted a model that included properties of mental representations (subjective quality of mental imagery and ease of imagination) as predictors of belief in future occurrence; this model

showed that the subjective quality of mental imagery (b = 0.27, SE = 0.07, t = 3.91, p < .001) and ease of imagination (b = 0.33, SE = 0.05, t = 5.92, p < .001) both uniquely contributed to the prediction of belief. Adding variables assessing the autobiographical context of events (i.e., personal importance, links to goals, planned events) to this model provided a significantly better fit, $\chi^2(4) = 89.47$, p < .001. All variables uniquely contributed to the prediction of belief, except relations to goals (b = -0.03, SE = 0.03, t = 1.17, p = .242) which was thus removed from the model. Next, the frequency of previous thoughts and similarity to past events were introduced in the model, which did not provide a significantly better fit to the data, $\chi^2(3) = 3.69$, p = .297; these two predictors were thus removed from the model. Finally, adding emotional valence provided a significantly better fit, $\chi^2(1) = 4.16$, p = .041; however, a robust model indicated that emotional valence did not provide unique contribution to the prediction of belief when other variables were taken into account (b = 0.04, SE = 0.04, t = 0.95, p = .34). Overall, the best and most parsimonious model for predicting belief in future occurrence included the subjective quality of mental imagery, ease of imagination, personal importance, and whether the events had been planned (see Table 3). This model accounted for 49% of the within-participant variance in belief in future occurrence.

Belief and actual occurrence. The main goal of our study was to investigate the extent to which ratings of belief in future occurrence predict the actual occurrence of events. To do so, we conducted a multilevel logistic regression with event occurrence as outcome and belief as predictor. This showed that the odds of event occurrence significantly increased with ratings of belief (b = 0.73, SE = 0.10, z = 6.93, p < .001); the odds of occurrence were 2.07 times higher with an increase of 1 unit on the belief scale (Figure 1A). As suggested by a reviewer, we also explored whether the actual occurrence of events was related to the various event characteristics that were measured in this study. Although some measures were related to the

actual occurrence of events (i.e., quality of mental imagery, ease of imagination, relation to plans, and similarity to past events; see Table S3 in the Supplementary Materials), these did not provide an additional contribution to the prediction of actual occurrence when belief in occurrence was taken into account, except for a small effect of similarity to past events (b = 0.14, SE = 0.06, z = 2.08, p = 0.038).

For events that actually occurred, we further examined whether belief in accuracy predicted ratings of the extent to which the events unfolded as the participants imagined. We fitted a linear multilevel model with ratings of the extent to which the events unfolded as imagined (provided during the second session) as outcome variable and ratings of belief in accuracy (provided during the first session) as predictor. This analysis showed that the extent to which events unfolded as imagined was significantly predicted by belief in accuracy (b = 0.26, SE = 0.08, t = 3.41, p < .001).

Discussion

The results of Study 1 provide initial evidence that the subjective sense that an imagined event will actually materialize in the future is not randomly generated but predicts the actual event occurrence. Our findings also replicate previous studies showing that belief in future occurrence is related to multiple characteristics of imagined events, including the quality of mental imagery, ease of imagination, the autobiographical context of the event, its repetition, and similarity to past experiences. When examining the unique contribution of these factors, we found that belief in future occurrence was predicted by both the quality of future thoughts (the vividness of mental imagery and ease of imagination) and their integration with autobiographical knowledge (personal importance and plans). These findings add to growing

evidence that autobiographical knowledge plays a central role in episodic future thinking (D'Argembeau, in press; D'Argembeau & Demblon, 2012; D'Argembeau & Mathy, 2011).

Study 2

In Study 2, we sought to replicate the findings of Study 1 regarding the predictive validity of belief in future occurrence. Furthermore, we aimed to investigate whether belief in future occurrence is influenced by the temporal distance of imagined events. While people are able to envision more or less distant futures, it has been argued that near future events (i.e., events expected in the next few days) are particularly accessible, which keeps us informed of upcoming goal-related activities (Conway et al., 2016). Previous studies have indeed shown that the frequency and specificity of future thoughts decrease with increasing temporal distance from the present (e.g., D'Argembeau et al., 2011; see also Trope & Liberman, 2003). Temporally close events might also subjectively feel more "real", thereby prompting us to prepare and organize upcoming activities. To test this hypothesis, we asked participants to imagine an event that might happen on each day of the coming week and we assessed their belief in the future occurrence of each event. We predicted that ratings of belief in future occurrence would decrease with increasing temporal distance from the present. Furthermore, as in Study 1, we expected that belief in future occurrence (1) would be predicted by both the quality of future thoughts and their integration with autobiographical knowledge, and (2) would predict the actual event occurrence.

Method

Participants. A total of 112 participants were initially tested, but seven of them were excluded either because they guessed the purpose of the study (n = 3), did not provide unique

events (n = 2), did not come to the second session on the scheduled day (n = 1) or provided ambiguous information about an event's actual occurrence (n = 1). The final sample included 67 women and 38 men, aged between 18 and 35 years (M = 22.8, SD = 4.1). We decided a priori to collect data in order to achieve a final sample size of about 100 participants. A priori power analyses indicated that a sample size of 7 events (level 1) and 100 participants (level 2) provided a statistical power above 90% to detect a medium effect size (beta = 0.30) for fixed effects (at level 1) both in linear and logistic multilevel regression models. All participants gave written informed consent and the study was approved by the Ethics Committee of the Faculty of Psychology of the University of Liège.

Materials and procedure. The instructions of the first session were the same as in Study 1, except that participants were asked to imagine an event for each day of the coming week (including the present day). To control for potential order effects, half of the participants started by imagining an event that might happen later the same day and then moved to the next day, the day after, and so on, until they had produced one event for each day of the entire week (7 events in total), whereas the other half of the participants started by imagining an event that might happen in 6 days and then moved backward to the present day. In addition, the same number of participants were tested on each day of the week (i.e., on a Monday, Tuesday, and so on) to control for potential effects of the structure of the week (e.g., weekends) on the characteristics of imagined events. As in Study 1, after having produced all events, participants imagined each event in as much detail as possible and then rated various characteristics of their mental representation while keeping the event in mind. The same rating scales as Study 1 were used, except that we only included one rating scale for emotional valence (given that the two scales were strongly related in Study 1) and we added

an item to assess the subjective temporal distance of the imagined event (1 = very close, 7 = very far).

Seven days after the first session, participants were asked whether or not they remembered describing each event during the first session, and whether or not the event occurred during the past week. When an event happened, participants had to report the day of its occurrence. The instructions and rating scales that were used in this study are available on OSF (https://osf.io/shfyz/). During debriefing, participants were asked whether thinking about the events in the context of this study influenced them (e.g., they executed an action because they mentioned it during phase 1). Three participants who reported that this was the case were excluded from the analyses.

Scoring of event content. The thematic content of reported events was categorized in the same way as in Study 1 and inter-rater agreement was almost perfect (Cohen's Kappa = .95).

Statistical analyses. As in Study 1, the relationships between belief in future occurrence and other measures were examined using linear multilevel regression analyses, and the prediction of the actual occurrence of events was assessed using a logistic multilevel regression model. To analyze changes in belief in future occurrence as a function of temporal distance, we conducted a growth curve analysis, which provides a way to assess and quantify the shapes of time course curves (Mirman, 2014). Ratings of belief over time were modeled with second-order orthogonal polynomials (i.e., linear and quadratic terms), and the model also included random effects of participants on time terms. The data and analysis scripts of this study are available on OSF (https://osf.io/shfyz/).

Results

Of the 735 future events that were reported, 462 actually happened (63%). Participants remembered having produced the event during the first session for 98% of events, but all events were included in the following analyses because participants could tell whether or not the event occurred even for events that they did not remember producing. The reported events involved social activities (29% of events), work or school-related activities (24% of events), leisure activities (25% of events), domestic and daily activities (21% of events), and health-related activities (1% of events). Descriptive statistics for belief in future occurrence and other measures are presented in Table 1.

Temporal distance and belief in future occurrence. The main aim of this study was to investigate whether belief in future occurrence varied with the temporal distance of imagined events. The ICC for belief in occurrence was 0.14, showing that most variance in belief (86%) was due to differences among events rather than differences between participants. To examine whether belief varied with temporal distance, we conducted a growth curve analysis with higher-order orthogonal polynomials (i.e., linear and quadratic terms) in order to assess the shape of changes in belief as a function of temporal distance (see the Method section for details). The linear (b = -0.47, SE = 0.11, t = -4.35, $p < .001$) and quadratic (b = 0.33, SE = 0.11, t = 2.86, p = .005) terms were both significant; as can be seen from Figure 2, belief in future occurrence decreased over the two days following the present and then remained more or less constant for the rest of the week.

Belief and actual occurrence. As in Study 1, a multilevel logistic regression model showed that the odds of event occurrence significantly increased with ratings of belief in occurrence

(b = 0.92, SE = 0.12, z = 7.76, p < .001); the odds of occurrence were 2.49 times higher with an increase of 1 unit on the belief scale (Figure 1). Adding temporal distance to this model showed that the odds of event occurrence decreased with increasing temporal distance (b = -0.15, SE = 0.04, z = 3.24, p = .001), but belief in occurrence remained a significant predictor of actual occurrence when this effect of temporal distance was taken into account (b = 0.88, SE = 0.11, z = 7.47, p < .001).

Determinants of belief in future occurrence. The bivariate relationships between the belief scale and other measures are shown in Table 4. As in Study 1, belief in future occurrence was related to the quality of mental imagery, ease of imagination, autobiographical context of events (importance and relations to goals and plans), and their familiarity (previous thoughts, similarity to past events, familiarity of location). The only difference with Study 1 was that belief was not significantly related to the emotional valence of events but was related to the control assigned to circumstances (i.e., belief decreased when the events were judged to depend to a greater extent on circumstances).

As in Study 1, we investigated the specific contribution of event characteristics to the prediction of belief using model comparisons. First, we fitted a model that included properties of mental representations (subjective quality of mental imagery and ease of imagination) as predictors; this model showed that the subjective quality of mental imagery (b = 0.32, SE = 0.05, t = 6.04, p < .001) and ease of imagination (b = 0.27, SE = 0.04, t = 6.12, p < .001) both uniquely contributed to the prediction of belief. Adding variables assessing the autobiographical context of events (i.e., personal importance, links to goals, planned events) to this model provided a significantly better fit, $\chi^2(5) = 279$, p < .001. However, relations to goals (b = -0.01, SE = 0.02, t = 0.63, p = .525) and personal importance (b = 0.05, SE = 0.03, t = 1.97, p = .051) did not uniquely contribute to the prediction of belief and were thus removed

from the model. Finally, adding the frequency of previous thoughts and similarity to past events in the model did not provide a significantly better fit to the data, $\chi^2(4) = 6.39$, $p = .172$. Overall, the best and most parsimonious model for predicting belief in future occurrence included the subjective quality of mental imagery, ease of imagination, and planned events (see Table 5). This model accounted for 53% of the within-participant variance in belief in future occurrence.

Discussion

The results of Study 2 replicated the findings that belief in future occurrence is a significant predictor of the actual occurrence of imagined events, and that such belief is determined by both the quality of mental representations (i.e., the vividness of mental imagery and ease of imagination) and the congruence of imagined events with autobiographical knowledge (i.e., relations to plans). Furthermore, in line with our hypothesis, we found that belief in future occurrence varied with the temporal distance of imagined events. More specifically, there was a quadratic relationship between belief in future occurrence and temporal distance, such that belief decreased over the two days following the present and then remained more or less constant for the rest of the week. This finding is in line with the view that events from the coming days are particularly salient in episodic consciousness to help us manage daily life activities (Conway et al., 2016). Our results thus add to previous studies on the effect of temporal distance on the characteristics of imagined events (e.g., Berntsen, 2019; D'Argembeau et al., 2011; Spreng & Levine, 2006; Trope & Liberman, 2003) by showing that in addition to the frequency and level of detail of future thoughts, the subjective realness of events increases with temporal proximity.

It should be noted, however, that we investigated variations in belief in future occurrence over a relatively short temporal period (the coming week) and that belief was still quite high for events that were imagined to happen in six days from now. It could be that belief in future occurrence would drop more dramatically for more distant futures (e.g., the coming months or years), although the modulation of belief with farther temporal distances remains to be investigated in detail.

General Discussion

To navigate the physical and social world we use mental maps of the future that are filled with expected events. While fundamentally all future events are uncertain, some imagined events are associated with a strong sense of realness (i.e., the belief that they will actually happen). Recent studies have shown that degrees of belief in future occurrence are determined by multiple factors, most notably the congruence of imagined events with autobiographical knowledge (Ernst et al., 2019; Ernst & D'Argembeau, 2017; Scoboria et al., 2020). The present research replicates these findings and further shows that the subjective sense that an imagined event will happen in the future is not random but predicts the actual event occurrence.

The capacity to construct mental simulations allows us to imagine myriads of future possibilities but the usefulness of prospection for guiding decisions and behavior depends on the accuracy of expectations (Roese & Sherman, 2007). In the present research, around 65% of events that participants envisioned for the following month (Study 1) or week (Study 2) actually happened. This rate of event occurrence is comparable to the rate observed in a previous study (61%) in which people were asked to imagine events for the coming year (Spreng & Levine, 2013); a somewhat higher rate (75%) was found in some other studies

(Marsh et al., 1998), presumably because these focused on the completion of intentions rather than any kind of future events. Most importantly, the present research shows that variations in belief in occurrence across imagined events predict the actual occurrence of events in the future: in both studies, the odds of event occurrence were about 2 times higher with an increase of 1 unit on the belief in occurrence scale. These results suggest that the phenomenology of future thoughts indicates the accuracy of expectations: belief in future occurrence is a cognitive feeling that provides information about the truthfulness of imagined events. Degrees of belief in future occurrence may then guide people's decisions and actions, thereby serving pragmatic purposes (Baumeister et al., 2016; Suddendorf & Corballis, 2007).

While belief in future occurrence can be influenced by multiple factors, it is largely determined by the congruence of imagined events with general knowledge about the self and one's life—events feel real because they are planned or because they are consistent with our personal life circumstances (D'Argembeau, in press; Ernst et al., 2019; Ernst & D'Argembeau, 2017; Scoboria et al., 2020). To illustrate this, consider the difference between imagining that you will be relaxing on the beach next weekend and imagining that you will be at the office working on a paper. If you know the deadline for submitting the paper is coming soon, the latter event will feel much more 'real' than the former. The subjective veridicality of imagined events thus depends on their integration within a personal context (Ernst et al., 2019). Our results showed that belief in future occurrence is also related to the subjective quality of mental imagery and ease of imagination—in line with previous research (Kahneman & Tversky, 1982; Koehler, 1991)—but the contribution of autobiographical knowledge remained significant when these dimensions of future thoughts were taken into account. From a broader perspective, these results are consistent with research on the determinants of subjective truth. Unkelbach and Rom (2017) argued that the judged truth of an unknown statement is a function of the number and coherence of references in memory

that give meaning to the elements in the statement. This theory was proposed to account for the judged truth of factual statements (e.g., "the most poisonous snake is the Australian Inland Taipan"), but it can easily be applied to prospection: the subjective truth of imagined future events may increase when these events are compatible with more elements stored in autobiographical memory, such as other planned events, personal characteristics, and goals.

An important function of prospection is to help us envision and prepare for multiple alternatives: viewed from the present, the future is represented as a matrix of possibilities that might or might not come true (Baumeister et al., 2018). The ability to consider multiple alternatives is particularly important for making long-term decisions and plans, but as the future gets closer the ability to identify events that are most likely to actually happen becomes essential to set up adaptive actions. Indeed, all else being equal, the range of future alternatives tends to decrease with temporal proximity: the present circumstances and events from the recent past—which are particularly accessible in consciousness (Conway et al., 2016)—constrain the matrix of possibilities to a limited set of near-future scenarios. The stronger belief in occurrence for near-future events observed in Study 2 might reflect this reduction process among future possibilities. In other words, belief in occurrence might serve the purpose of prioritizing future scenarios that are most relevant to one's current autobiographical context.

While in this study we focused on intra-individual variations in belief (i.e., differences among imagined events), it deserves mention that individual differences may also significantly impact belief in future occurrence. For example, there is evidence that the perceived likelihood of negative events is increased in people with depressive and anxiety symptoms (e.g., Cropley & MacLeod, 2003; Dickson & MacLeod, 2006; Miranda & Mennin, 2007). The extent to which other individual differences that have been related to episodic future thinking (such as personality, visual imagery, and time perspective; Arnold et al., 2011;

D’Argembeau & Van der Linden, 2006; Quoidbach et al., 2008) also modulate belief in future occurrence remains to be investigated in detail.

In conclusion, the present research suggests that the synergy between imagined events and autobiographical knowledge is at the center of the phenomenological experience of mental time travel into the future: the sense of projecting oneself in the future depends on the conviction that what one imagines will genuinely occur. Such belief in future occurrence is not random but indicates the truthfulness of imagined events, which may then guide decisions and actions in daily life.

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Table 1. Means and standard deviations for all scales in Studies 1 and 2

	Study 1		Study 2	
Variable	*M*	*SD*	*M*	*SD*
Belief in occurrence	5.49	1.36	5.52	1.22
Mental imagery	4.63	1.50	5.15	1.16
Ease of imagination	5.35	1.60	5.43	1.29
Importance	5.11	1.45	4.35	1.51
Goals	3.86	2.36	3.57	2.22
Planned	4.42	2.04	4.72	2.12
Previous thoughts	4.21	1.82	3.72	1.85
Similarity to past	4.37	2.06	4.88	1.88
Control self	4.78	1.85	4.77	1.81
Control others	4.62	1.95	4.35	1.99
Control circumstances	2.60	1.49	2.65	1.64
Familiarity location	4.98	2.27	5.70	1.86
Emotional valence	1.73	1.29	1.04	1.45
Belief in accuracy	4.26	1.59	4.81	1.43
Subjective distance	-	-	3.30	1.63

Table 2. Bivariate relationships between belief in future occurrence and other measures in Study 1

Predictor	*b*	SE	*t*	*p*
Mental imagery	0.43	0.07	6.26	< .001
Ease of imagination	0.45	0.06	7.64	< .001
Importance	0.33	0.06	5.29	< .001
Goals	0.09	0.03	2.93	.004
Planned	0.32	0.03	10.57	< .001
Previous thoughts	0.18	0.04	4.36	< .001
Similarity to past	0.18	0.04	4.55	< .001
Control self	-0.01	0.04	-0.14	.888
Control others	0.05	0.04	1.22	.235
Control circumstances	-0.05	0.05	-1.02	.308
Familiarity location	0.09	0.04	2.02	.050
Emotional valence	0.19	0.07	2.78	.009

Note: event characteristics that are significantly related to belief in occurrence are indicated in bold

Table 3. Final model investigating the unique contribution of event characteristics to the prediction of belief in future occurrence in Study 1

Predictor	*b*	SE	*t*	*p*
Mental imagery	0.18	0.06	3.27	.003
Ease of imagination	0.29	0.05	5.70	< .001
Importance	0.10	0.04	2.28	.023
Planned	0.23	0.03	7.90	< .001

Table 4. Bivariate relationships between belief in future occurrence and other measures in Study 2

Predictor	*b*	SE	*t*	*p*
Mental imagery	0.50	0.04	11.52	< .001
Ease of imagination	0.42	0.04	11.57	< .001
Importance	0.22	0.03	6.56	< .001
Goals	0.10	0.02	4.64	< .001
Planned	0.34	0.02	14.62	< .001
Previous thoughts	0.18	0.03	5.90	< .001
Similarity to past	0.12	0.03	4.36	< .001
Control self	0.03	0.03	0.98	.329
Control others	0.01	0.02	0.56	.572
Control circumstances	-0.08	0.03	2.53	.012
Familiarity location	0.06	0.03	2.27	.026
Emotional valence	-0.01	0.03	0.41	.687

Note: variables that are significantly related to belief in occurrence are indicated in bold

Table 5. Final model investigating the unique contribution of event characteristics to the prediction of belief in future occurrence in Study 2

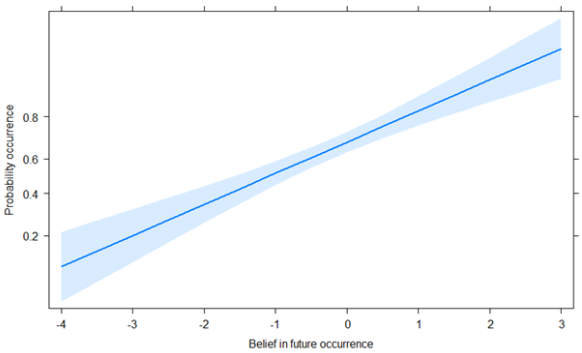
Predictor	*b*	SE	*t*	*p*
Mental imagery	0.26	0.04	6.21	< .001
Ease of imagination	0.18	0.04	5.14	< .001
Planned	0.30	0.02	13.34	< .001

Figure legends

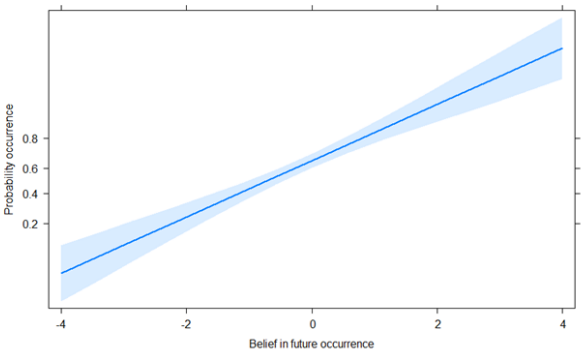
Figure 1. Effect display for the multilevel logistic regression model with actual occurrence as outcome and belief in occurrence (cluster-mean centered) as predictor in Studies 1 and 2. The fitted effect is shown with its 95% CI.

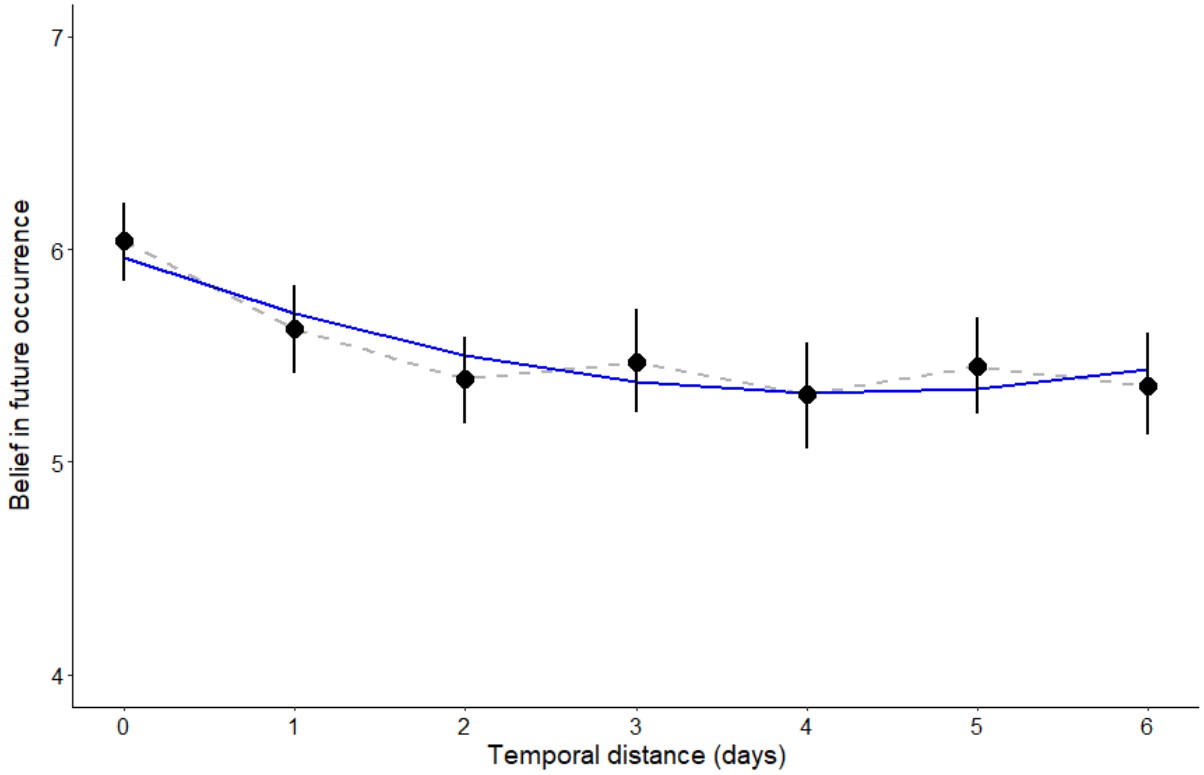
Figure 2. Belief in future occurrence as a function of temporal distance in Study 2. The blue line represents the fitted quadratic term. Error bars represent the 95% CI.

A


Study 1
Probability occurrence
0.8
0.6
0.4
0.2
-4
-3
-2
-1
0
1
2
3
Belief in future occurrence

B


Study 2
Probability occurrence
0.8
0.6
0.4
0.2
-4
-2
0
2
4
Belief in future occurrence


Belief in future occurrence
7
6
5
4
0
1
2
3
4
5
6
Temporal distance (days)