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Metamemory appraisals in autobiographical event recall

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ABSTRACT

Two studies examined whether belief in the occurrence of events, recollecting events, and belief in the accuracy of recollections are distinct aspects of autobiographical remembering. In Study 1, 299 student participants received a cue to recall five childhood events, after which they rated each event on these constructs and other characteristics associated with remembering. Structural equation modelling revealed that variance in ratings was best explained by the three anticipated latent variables. In Study 2, an online sample of 1026 adults recalled and rated a childhood event and an event about which they were somehow uncertain. Confirmatory modelling replicated the three latent variables. The relationship of key predictors (perceptual detail, spatial detail, re-experiencing, and event plausibility) to the latent variables confirmed the distinction. These studies demonstrate that belief in occurrence and belief in accuracy appraisals are distinct, the former indexing the truth status of the event and the latter the degree to which the event representation accurately reflects prior experience. Further, they suggest that belief in accuracy indexes the monitoring of the quality of recollections.

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1. Introduction

For at least the past half-century, researchers have done an admirable job of describing the phenomenology of autobiographical memory (AM). Features of remembering like vividness and visual perspective are well described. Further work has examined how these properties are influenced by event features (e.g., emotion or time since occurrence) or by cognitive processes (e.g., imagination). Yet, Baddeley (2012) recently encouraged researchers in the area to integrate such diverse topics into broader theoretical understandings. Some theoretical and empirical efforts to integrate these individual findings into a more complete picture of AM processing have been made (Conway, Singer, & Tagini, 2004; Rubin, 2006). Importantly, integration must be done with a clear understanding of the dissociable constructs that contribute to the experience of remembering events.

In this work, we continue this line of inquiry via discussion of three concepts developed in prior work which have yet to be simultaneously disentangled. This paper examines the degree to which believing that events occurred (*autobiographical belief*), recollecting events (*recollection*), and appraising the accuracy of recollections (*belief in accuracy*) are distinct components of remembering.

Before discussing these concepts, we emphasize that our focus is not on the objective accuracy of memories. With autobiographical remembering, the objective details of events as originally experienced are not available for verification in the same way that an investigator can ascertain the accuracy of recall of a word presented on a list earlier in an experimental session. Even in cases where photographs or diaries exist to corroborate past events, memories remain subjective appraisals that are based on

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the information available at the time of remembering. When external evidence challenges a memory, an individual may choose to doubt the evidence as readily as changing his or her belief in the accuracy of the memory.

The availability of 'objective' information is only part of the problem of assessing accuracy in autobiographical memory. Real-world events include a staggering amount of multimodal information experienced over relatively lengthy time spans. To expect complete and accurate retrieval of all of this information seems an unreasonable standard for accuracy. Even if one were theoretically able to remember all of the details of a prior event, how this information is reported becomes a problem. There are systematic influences of linguistic and narrative conventions on free recall, and there are limitations of expression for perceptual and emotional experiences. Characteristics of the retrieval environment influence the type and amount of information that is reported, such that reports about the same event made in different contexts can vary substantially and yet be similarly accurate (Blank, 2009; Drivdahl & Hyman, 2014). Therefore, although perhaps odd from the perspective of traditional memory investigators, the study of autobiographical remembering can be advanced with little reference to objective accuracy.

Our work builds on the tradition that views remembering as to some degree reconstructive in nature, and that labelling mental representations as 'memories' or otherwise reflects metacognitive attributions based on mental experience at the time of remembering (Johnson & Raye, 1981; Neisser, 1967; Rubin, 2005). A number of approaches share the proposition that multiple metacognitive appraisals contribute to remembering (Mazzoni & Kirsch, 2002; Rubin, 2006; Scoboria et al., 2014). In one of the more comprehensive efforts, Brewer (1996) defined autobiographical memories as possessing the distinct components of vivid imagery, belief that the resulting mental representation represents the past faithfully, and belief that the represented events genuinely occurred.

1.1. Recollection

Reminiscence includes conscious awareness of remembering, re-experiencing of perceptual details of the event, recognizing the spatial and temporal characteristics of the event, and novel appraisal of the event as it influences current emotion. This cumulative recollective experience results in a subjective feeling of re-experiencing the past that differentiates remembering from imagining (Tulving, 1985). A large body of work illustrates that recollective experience (variously named episodic memory; believed memory; recollective memory) makes key contributions to remembering when present (Tulving, 1983; Johnson, Hashtroudi & Lindsay, 1996; Cabeza & Moscovitch, 2013; Yonelinas, 2002).

There is a clear distinction between the mental simulation and the recollection of events (Addis, Pan, Vu, Laiser, & Schacter, 2009). As discussed in the work on source monitoring (Johnson, Hastroudi, & Lindsay, 1993), it is possible to differentiate subjective experiences of remembering from imagining, without defining remembering as being objectively related to past events and imagining as being independent of objective reality. Therefore, an individual may recollect an event that did not in fact occur and yet still identify that experience as distinct from fantasizing about an event that is known not to have occurred. Recollection can thus be viewed as the presence of an episodic mental simulation accompanied by a sense of re-experiencing.

1.2. Autobiographical belief

Autobiographical belief (also *belief in occurrence*), is the belief that an event occurred to the self in the past. While memories have long been recognized as including a sense of genuineness (e.g., James, 1890; Lampinen & Odegard, 2006; Pillemer, 1998; Rubin, 2012; Tulving, 1983), less attention has been directed to the degree that recollection and autobiographical belief are dissociable. A growing body of evidence supports such a distinction (Mazzoni & Kirsch, 2002; Mazzoni, Scoboria, & Harvey, 2010; Scoboria, Mazzoni, Kirsch, & Reyea, 2004). Suggesting false events frequently results in reports that events occurred without accompanying recollection (Bernstein, Pernat, & Loftus, 2011; Hart & Schooler, 2006; Scoboria, Lynn, Hessen & Fisico, 2007). Studies of nonbelieved memories show the converse case, in which the strength of recollection exceeds that of autobiographical belief (Clark, Nash, Fincham, & Mazzoni, 2012; Mazzoni, Nash, & Clark, 2014; Otgaar, Scoboria, & Smeets, 2013; Scoboria & Talarico, 2013).

Scoboria et al. (2014; see also Scoboria & Talarico, 2013, Study 3) demonstrated that recollection and autobiographical belief form distinct latent constructs, that each is predicted by different variables, and that their correspondence varies depending on the type of event under study. Autobiographical belief judgments are influenced by a wider variety of processes and sources of information. These include the presence of recollection, the plausibility of events, and social feedback about events, to select just three of the more prominent influences (Scoboria, Boucher, & Mazzoni, in press; Wade, Nash, & Garry, 2014). Such observations have led to the proposition that autobiographical belief is the summative appraisal of all evidence available at the time that an event is remembered (Scoboria et al., 2014).[1]

1.3. Belief in accuracy

The distinction between autobiographical belief and belief in the accuracy of a recollected mental simulation is the difference between asking "Did this event occur?" and "Am I remembering this event in the way that it occurred?" When an event is recollected, the details of that recollection become subject to evaluation. The default assumption is that one would believe the contents of a recollection. However, most individuals are open to re-evaluating their memory from time to time if confronted with skepticism, contradictory evidence, or a need

[1] See Scoboria and Talarico (2013) for discussion of the relationship between autobiographical belief and the remember/know distinction.

to reconcile discrepant information about the self (Pasupathi, 2001; Wilson & Ross, 2003). The contents of recollections can be revised (e.g., a yield sign transformed into a stop sign) without influencing the overarching appraisal that the event did occur. Discussions of the social functions of remembering point to the possible gains realized when people achieve reasonable agreement within groups about the details of shared past experiences, for example increased social cohesion (Alea & Bluck, 2003; Pillemer, 1998). Questions regarding belief in accuracy may be thought of as potential errors of commission – misremembering details by confusing aspects of one event with another, by incorporating post-event information, or constructing details of an event based on schematic information. Belief in accuracy is the individual's functional assessment of the accuracy of what is recalled (again, independent of what might be considered "objective" accuracy).

Rubin (2006) includes both recollection and belief in accuracy appraisals in his Basic Systems model, arguing that each reflects distinct metamemorial processes. *Belief in accuracy* is the degree to which a recollected event is appraised to correspond to what was experienced at the time of the event, that is, the subjective sense of correspondence between the present and the past. Evidence supports such a distinction at the measurement level within autobiographical memory (Rubin, Schrauf, & Greenberg, 2003; Fitzgerald & Broadbridge, 2012), and some relationships with individual difference variables have been established (Rubin & Siegler, 2004).

In at least some ways, discussions of the monitoring and control of memory are similar to that of belief in accuracy. Koriat and Goldsmith's (1996) strategic memory regulation model proposes that the retrieval of items from memory and the monitoring of the accuracy of retrieved information arise from distinct processes. In this approach, the subjective accuracy of retrieved information is assessed using confidence ratings. As such, belief in accuracy appraisals in the context of AM and confidence ratings for items of knowledge in the metamemory literature are conceptual relatives.

Much of the work on accuracy monitoring is conducted using single items from within observed events (e.g., Howie & Roebers, 2007; Loftus, Miller, & Burns, 1978; Odinot & Wolters, 2006; Sauer, Brewer, & Weber, 2012), newly learned items (e.g., Dodson & Schacter, 2002; Hart, 1967), or items of general knowledge (e.g., Ackerman & Goldsmith, 2008; Koriat & Goldsmith, 1996). The monitoring of whole events, which are comprised of multiple features and related knowledge bound together within a spatial/temporal frame, is presumably more complex. The literature on memory distortion has long distinguished between memory for details and memory for events. Early papers on false memory formation argued that the effects of misinformation on event details are not of the same type as the development of robust false memories for events (Bruck & Ceci, 1999; Loftus & Pickrell, 1995). Hyman & Pentland (1996) argued that the fabrication of false memories requires the development of complete, emotional, and self-involved mental representations. Thus while confidence for individual items and belief in accuracy are related, the latter is a more complex summative appraisal of the correspondence between what is recollected and what occurred in the past.

This constellation of constructs is not inconsistent with what we know of the neural underpinnings of autobiographical remembering. Event representations are retained in both hippocampal and cortical regions (Moskovitch, 2012), speaking to different modes by which event representations can be subjectively experienced. Precuneus activity has been associated with vivid visual imagery necessary to maintain recollection (Rubin & Greenberg, 2003). Moscovitch (2008) proposes that recollection relies heavily on the hippocampal region, whereas evaluation of the veridicality of retrieved material is processed in other brain regions. The engagement of the medial temporal lobes in reconstructing and recombining details of retrieved events (Eichenbaum, 2001) may provide the basis for belief in accuracy judgments. Given that spontaneous retrieval may be more common in everyday AM than deliberate search (Berntsen, 2012; Uzer, Lee, & Brown, 2012), right prefrontal activity previously associated with memory accessibility and "retrieval mode" (Nyberg, Tulving, Habib, et al., 1995) may correspond to belief in occurrence monitoring. Similarly, medial prefrontal cortex activity previously related to self-referential processing (Craik et al., 1999; St. Jacques, Conway, Lowder, & Cabeza, 2011) has been associated with "a collection of processes including: decision making under uncertainty, control processes providing a 'feeling of rightness' and the processing of self-referential information that combine to monitor the veracity of autobiographical memories" (Gilboa, 2004, as cited by Daselaar et al., 2006 p. 224) all of which would seem to parallel belief in occurrence assessment as defined by Scoboria et al. (2014). Therefore, we have good reason to believe that these three distinct components are necessary, though not sufficient, for autobiographical remembering.

1.4. The current research

The distinction among recollection, autobiographical belief, and belief in accuracy in the literature is not straightforward. As discussed, recollection has been a defining feature of AM from the earliest theoretical work. However, the term 'belief' is used loosely in the literature. In some formulations, belief is associated with the absence of memory (Johnson, Raye, Mitchell, & Ankudowich, 2012). What is measured in some work more closely resembles what we describe here as belief in accuracy, but it is often discussed in terms more closely resembling belief in occurrence. These two types of belief are conflated in much of the preceding research because both spontaneous generation and laboratory cueing of events typically elicits vividly recollected events that are believed to have occurred and which are viewed to be accurate (Scoboria & Talarico, 2013). In other words, autobiographical belief and belief in accuracy appear to be synonymous because research often elicits memories for which both co-occur at high levels. Furthermore, everyday experience of AM assumes belief in occurrence. Perhaps because of this inconsistency, earlier work on dissociating recollection and belief has

demonstrated greater reliability in describing recollection than 'belief' (Fitzgerald & Broadbridge, 2013; Rubin et al., 2003).

Research as to whether the three concepts are empirically dissociable is needed. If belief in occurrence and belief in accuracy represent distinct facets of remembering, presumably the concepts can be measured simultaneously and their relationship estimated. Below we report two studies that test if recollection, autobiographical belief, and belief in accuracy can be modeled concurrently. In Study 1, we used a cueing method to elicit multiple events for which these constructs were rated. Structural equation modelling techniques were employed to examine whether responses were best explained by the three theorized latent variables. In Study 2, we validated the resulting model using confirmatory modelling techniques.

All procedures described below received clearance from the University of Windsor Research Ethics Board and the IRB at Lafayette College.

2. Study 1 Method

2.1. Participants

The participants were 299 students (79% female; M_{age} = 22.34, SD = 4.55, range 18–50) at the University of Windsor who received course credit.

2.2. Measures

2.2.1. Belief in occurrence (autobiographical belief)

Belief in the occurrence of events was measured using the three item scale from Scoboria et al. (2014). The items query likelihood of occurrence, strength of belief that the event occurred, and the event as having truly occurred. The first item was derived from the ABMQ (Scoboria et al., 2004), and is answered using an 8-point scale, and the second and third items are answered using 7-point scales.

2.2.2. Recollection

Recollection of events was measured using the three item scale from Scoboria et al. (2014). The items query remembering, strength of memory, and remember vs. knowing. The first item is from the ABMQ (Scoboria et al., 2004), and is answered using an 8-point scale. The third item originated from Rubin, Schrauf & Greenberg (2001). The second and third questions are answered using 7-point scales.

2.2.3. Potential predictors of belief in accuracy

Seven items developed in pilot work were included as potential indicators of belief in accuracy. To develop the items, we started from the items that Rubin et al. (2003) used to assess their conceptualization of 'belief'. We then adapted the items and generated items that we though matched the conceptualization of belief in accuracy described above, with the goal of producing items that clearly tapped a single concept. All items were rated on 7-point scales. The resulting 10 items were administered in a pilot study, in which 10 participants selected one autobiographical memory and spoke aloud, commented on item clarity, and described what they thought each item was asking them to rate. We selected seven items to include in the study: confidence that the memory is accurate, proportion of the memory that is accurate, degree to which the memory is distorted, doubts as to accuracy of the memory, whether details are missing from the memory, whether the memory has changed over time, and whether the memory comes to mind in pieces. Full text of all items contributing to the latent variables can be found in Appendix A.

2.2.4. Additional memory characteristics

Additional items taken from preceding work served as covariates with the theorized latent constructs (Johnson, Foley, Suengas & Raye, 1988; Rubin, Schrauf & Greenberg, 2001; D'Argembeau & Van der Linden, 2004). Three indicators previously associated with recollection included perceptual detail, re-experiencing, and mental time travel. A single item assessed the personal plausibility of events, as plausibility has previously been associated with autobiographical belief. Additional items associated with autobiographical remembering in preceding work included spatial detail, narrative coherence, susceptibility to persuasion, rehearsal, and emotion (intensity, positive affect, negative affect). All items were rated using seven point Likert-style scales.

2.3. Procedure

We used the procedure from Scoboria and Talarico (2013) to cue participants to recall five events. Participants read a brief introduction, and were then cued to provide a brief 3–4 word prompt sufficient to remind them of each event later in the study for five separate autobiographical events from age 6–12. This age range was selected because it produced the greatest variability in autobiographical belief and recollection ratings in their studies. After this cueing, participants were provided with the prompts in random order and they rated each of the five events using the autobiographical belief, recollection, belief in accuracy, and memory characteristic items described above. Important to note is that all events are selected by the participants prior to making the ratings, thus knowledge of the purpose of the research did not bias event selection.

2.4. Modelling approach

All structural equation models were tested using EQS Version 6.1, using robust estimation (to account for some skewness in some variables) for chi-square, fit indices, and standard errors. We additionally employed bootstrapping of 1000 samples to further assess the stability of model parameters. We used the recommendations by Jackson, Gillaspy and Purc-Stephenson (2009) to assess model fit, and report chi-square, CFI and RMSEA indices for assessing the absolute fit of models to the data, and the AIC index when comparing hierarchically nested models. Bias corrected confidence intervals for path coefficients

and correlations based on bootstrapping of 1000 samples are reported throughout the results.

The modelling in Study 1 was conducted in three stages. First, the suitability of treating the potential belief in accuracy items as a single latent variable was explored, and items were selected for inclusion in the models. Second, a series of structural models of different complexity were fit to the data to identify the best fitting model. The purpose of this stage is to examine the assertion that three latent variables (recollection, belief in occurrence, belief in accuracy) are required to account for variability in ratings, rather than some smaller number of latent variables. Third, the covariates were added to the final model identified in the prior step to assess their relationship with the LVs. We estimated path coefficients between the predictors and LVs (treating the covariates as predictors of the LVs), and also estimated covariance between the predictors and LVs. This stage examined two manners in which the predictor variables related to the LVs that resulted from the second stage.

3. Study 1 results

3.1. Data screening and exploration

A small number (<2%) of randomly distributed missing values were imputed using the expectation maximization procedure in SPSS v21.0. Each variable was averaged across the five events for analysis, resulting in a single score for each item for each participant. Examination of multivariate outliers led to the removal of 14 extreme cases. Examination of item distributions indicated that all items were normally distributed, excepting (as expected) that the autobiographical belief items tended to be rated toward the scale ceiling. Scoboria et al. (2014) reported distinct autobiographical belief and recollection factors under similar conditions, and the robust estimation and bootstrapping techniques used to fit models directly addressed this non-normality in item distributions.

Prior to fitting the hypothesized LVs to the data, we examined correlations between the seven potential belief in accuracy items. Due to finding a range of magnitude in the relationships, we conducted an exploratory factor analysis to determine if item covariance was better explained by one or multiple factors, using the principal factor extraction method. Based on the eigenvalue and scree methods, two factors explained 77.42% of item variance. The first factor contained four items with loadings above .70 and no cross-loading on the second factor (proportion accurate, confidence, distorted, doubts) which reflected our conceptualization of belief in occurrence. We used these four items to model belief in occurrence below.[2]

3.2. Structural equation models

We fit a series of structural equation models to test the prediction that separate recollection, belief in occurrence, and belief in accuracy latent variables underlie decisions about autobiographical events. In Model 1, all 10 items were loaded onto a single LV; the fit of this model was expected to be poor. In Model 2, the three recollection items were loaded onto a recollection LV and the remaining seven items onto a general 'belief' LV. This model addresses whether belief in occurrence and belief in accuracy are conceptually redundant and reflect similar underlying processes. In Model 3, the three autobiographical belief items were loaded onto one LV, and the other seven items onto a second LV. This model addresses whether the belief in accuracy and recollection items tap redundant processes. Because we theorize that belief in accuracy indexes monitoring processes that contribute to recollection, the correlation between belief in accuracy and recollection is expected to be high. Hence the need to examine whether separate LVs are required. In Model 4, the three recollection and three autobiographical belief items were loaded onto separate LVs, and the four new items onto a third LV. This model addresses the question if recollection, belief in accuracy and belief in occurrence are distinct aspects of remembering.

Table 1 provides fit indices for the models, and item loadings are in Table 2. Per all fit indices, Model 4 (three factors) fit the data well and notably better than the other models. Thus the anticipated recollection, autobiographical belief, and belief in accuracy (four items) latent variables emerged. Belief in occurrence was estimated to correlate with recollection at .56 [95% CI, .44, .68] and with belief in accuracy at .45 [.33, .57]. Recollection correlated with belief in accuracy at .85 [.79, .90].

We next introduced the covariates into Model 4.[3] Single item covariates included perceptual detail, spatial detail, negative emotion, and susceptibility to persuasion. The reliving and mental time travel items were loaded onto a 're-experiencing' latent variable. In one model, pathways from each covariate to each LV were estimated. In a second model, correlations between each predictor and LV were estimated. Based on prior findings, we expected that personal plausibility would be related to autobiographical belief more strongly than the other LVs, and that perceptual detail and re-experiencing would be more strongly associated with recollection. Due to the theorized close relationship between recollection and belief in accuracy, we anticipated that some of the same variables would be associated with both LVs. All of the covariates were permitted to correlate, because our focus was to assess the relationship between the covariates and the LVs; it is for this reason that the fit of the model when including the covariates is expected to be slightly poorer than the best fitting model above.

The fit of the final model with the predictors added (Model 4a in Table 1) was good. The path coefficients and estimated correlations are provided in Table 2. Regarding the path coefficients, autobiographical belief (Cronbach's $\alpha = .85$) was predicted strongly by personal plausibility, and moderately by spatial detail and susceptibility to persuasion (negatively). Recollection ($\alpha = .88$) was predicted

[2] The potential presence of a fourth factor, cohesion among details in the event representation, in the data for both studies is described in supplement.

[3] The three emotion items and the rehearsal item showed no notable relationships with any of the LVs, and were dropped from the analyses.

Table 1
Study 1, structural model fit for varying levels of model complexity.

	df	χ^2	CFI	SRMR	RMSEA [90% CI]	AIC[b]
Model 1, 1 LV	55	492.06	.78	.04	.21 [.20, .23]	532.06
Model 2, 2 LVs (recollection; Belief in occurrence plus 4 items)	34	414.17	.82	.04	.20 [.18, .22]	456.17
Model 3, 2 LVs (belief in occurrence; recollection plus 4 items)	34	169.18	.92	.04	.13 [.11, .15]	243.05
Model 4, 3 LVs (recollection, belief in occurrence, belief in accuracy)	23	59.20	.99	.02	.06 [.04, .08]	111.20
Model 4a, 3 LVs with additional predictors (all paths included)[a]	85	216.31	.97	.03	.07 [.06, .09]	

Models 1 through 4 test whether reports are best described by one, two or three latent variables.
[a] Model 4a is expected to not fit the data as well as Model 4, as the purpose of this model is to estimate the relationships between predictors and the LVs and not to account for all variance in the predictors.
[b] AIC is reported for models that include the same observed variables. Model 4a uses different variables and the respective fit indices cannot be directly contrasted with the other models.

Table 2
Study 1, loadings of indicators on latent variables.

Item	LV	Estimate	95% CI	
Memory	Recc	.84	.77	.89
Memory strength	Recc	.86	.80	.90
Remember/know	Recc	.84	.77	.88
Belief	B.occ	.81	.71	.87
Belief strength	B.occ	.84	.75	.91
True event	B.occ	.80	.67	.89
Doubt	B.acc	.89	.85	.92
Proportion accurate	B.acc	.92	.90	.95
Confidence	B.acc	.82	.78	.86
Distorted	B.acc	.85	.78	.90

Loadings of the items on the latent variables (LVs) by study. B.occ – Belief in occurrence; Recc – Recollection; B.acc – Belief in accuracy. Bias corrected 95% confidence intervals are based on 1000 bootstrapped samples.

strongly by perceptual detail; moderately by re-experiencing and spatial detail; and weakly by spatial detail, plausibility and persuasion (negatively). Belief in accuracy (α = .92) was predicted strongly by perceptual detail; moderately by narrative coherence; and weakly by persuasion (negatively). The estimated correlations between the covariates and the LVs mirrored this pattern. Plausibility and belief in occurrence shared substantial variance, whereas plausibility was not notably related to the other LVs. Both perceptual detail and re-experiencing shared substantial variance with recollection and belief in accuracy, but not with belief in occurrence (see Table 3).

4. Study 1 summary

This study supports the assertion that belief in occurrence, recollection, and belief in accuracy reflect distinct components of the experience of remembering. Item variance was best explained by three distinct latent variables. The inclusion of the predictors in the final model confirmed a strong relationship between plausibility and autobiographical belief, but not with recollection or belief in accuracy. Perceptual detail strongly predicted recollection and belief in accuracy, consistent with conceptualizations of perceptual imagery as central to episodic recollection. Re-experiencing was uniquely associated with the recollection LV, consistent with the notion that the experience of imagery for memories is differentiated from imagery for other mental representations in part by the presence of a re-experiencing signal. Spatial detail was related to belief in occurrence and recollection, but not belief in accuracy which is not consistent with prior work (Rubin, Schrauf & Greenberg, 2001).

To assess the generality of the findings, we conducted a second study in a larger, more representative sample.

5. Study 2 method

5.1. Participants

We recruited a sample of Mechanical Turk workers. Turk is an online work-for-hire site where task requests

Table 3
Study 1, standardized path coefficients and correlations between covariates and latent variables.

Covariate	Latent variable					
	Recollection		Belief in occurrence		Belief in accuracy	
	Path coefficient[a]	R^{2b}	Path coefficient	R^2	Path coefficient	R^2
Perceptual detail	**.43 [.28, .56]**	.78	−.07 [−.16, .03]	.11	**.52 [.35, .68]**	.66
Spatial detail	**.16 [.07, .27]**	.47	**.22 [.10, .36]**	.21	−.06 [−.15, .03]	.24
Re-experiencing[c]	**.22 [.06, .41]**	.71	−.02 [−.24, .23]	.10	.02 [−.15, .20]	.51
Personal plausibility	**.08 [.01, .14]**	.06	**.45 [.32, .58]**	.31	.03 [−.04, .09]	.02
Persuade	**−.11 [−.18, −.04]**	.23	**−.30 [−.42, −.19]**	.20	**−.19 [−.27, −.12]**	.24
Narrative coherence	**.16 [.03, .28]**	.57	.12 [−.04, .26]	.09	**.30 [.18, .42]**	.54

Note: Path coefficients are standardized regression weights. Weights for which the path coefficient is estimated to not overlap with zero are in bold. 95% confidence intervals in brackets are based on 1000 bootstrapped samples.
[a] Model with standardized path coefficients between covariates and the LVs; covariates treated as predictors of the LVs.
[b] Model with correlations estimated between covariates and the LVs.
[c] Re-experiencing was entered into the model as a latent variable with two indicators (reliving, mental time travel).

can be posted for workers to complete. Turk workers are required to produce quality work to remain eligible for subsequent tasks, hence they tend to perform tasks conscientiously. Various studies have documented that data gathered via Turk is of good quality (e.g., Buhrmester, Kwang, & Gosling, 2011; Shapiro, Chandler, & Mueller, 2013), providing that the research design is suitable to online administration and validity checks are incorporated. In light of the brevity of the procedure, we paid all workers who provided at least one data point.

A total of 1026 respondents completed the 10 min. survey and received $0.75 USD. The characteristics of the complete sample were: 47.3% female, 50.2% male, 2.5% genderqueer or no response; M_{age} = 32.50, SD = 11.25, range 18–72; self-identified ethnicity, 9.4% Asian, 5.8% black, 4.9% Hispanic, 1.8% mixed, 0.4% Native American, 73.9% white; 94.2% USA resident. See below for data screening and verification procedures and final numbers included in analyses.

5.2. Measures

The items were the same as in Study 1, with the following exceptions (see Appendix A for items). A new item that assessed the completeness of the memory representation was added for exploratory purposes (see the Supplement for more information). To further situate the measurement of belief in accuracy in relation to Rubin's work, two additional items from Rubin et al. (2001) were included (belief in memory; testify). To keep the number of ratings low due to time constraints, the predictors were: personal plausibility, perceptual detail, spatial detail, setting (new in Study 2), reliving, and mental time travel, bringing the total number of items to 22.

5.3. Procedure

Participants followed a link to a secure online survey. They first recalled any childhood event using the same cue instruction as in Study 1 and rated the event. They then recalled an event about which they were uncertain, with no age specified. The instructions were:

> Please think about an event for which you are uncertain about what you remember. This might mean that you are not certain about all of the details that you recall, that something seems to be missing from what you remember, that something is just not quite right about the memory, or you may not have a memory for the event at all.

This prompt was intentionally broad to encourage retrieval of a variety of uncertain events. Participants rated the properties of the memory and then described why they were uncertain about the event before providing demographic information.

5.4. Data screening

Time to complete the survey (M_{time} = 8 m 30 s) and three embedded validity checks were examined. A total of 27 individuals completed the survey in less than 2 min. and/or provided inconsistent responses that did not pass all validity checks and were removed. Examination of multivariate outliers for the childhood event led to the removal of 11 cases, resulting in a total of 988 usable events. The reasons provided for being uncertain about the second event were reviewed, and 57 cases were dropped because the respondent wrote that they were not uncertain or provided no explanation. Another nine multivariate outliers were removed, leaving a total of 933 usable cases for the uncertain event. Thus 933 individuals provided valid responses for both events, and were used in the analyses described below.[4]

5.5. Modelling approach

Modelling was conducted using the same estimation and fit indices as in Study 1. We adopted the approach for modelling events used by Scoboria et al. (2014, Study 2), and modelled both events simultaneously. As our primary goal was to confirm the best fitting structural model (Model 4) from Study 1, we fit that exact model to the new dataset. Second, we explored adding the additional indicators to the belief in accuracy LV. This resulted in the final structural model. Third, we added the predictors to the final model.

6. Study 2 results

The first model assessed whether the final structural model (Model 4) from Study 1 fit the data for both the childhood and uncertain events, when modelling the three latent variables for the two events simultaneously. Thus a total of six LVs were estimated, with each of the three constructs (recollection, belief in occurrence, belief in accuracy) modelled twice. Correlations between the LVs within each event were also estimated, and repeated items were permitted to covary to account for variance due to repeated measures. The model fit the data well, χ^2 (141) = 360.21, CFI = .985, SRMR = .052, RMSEA = .040 (.035, .046).

In the second model, we explored adding the two additional indicators of belief in occurrence. Adding the 'belief in memory' item led to a notable decrease in model fit, and the item did not load highly on the belief in accuracy LV. This finding is consistent with Scoboria et al. (2014), and is likely because this item refers to multiple concepts; the item was dropped from further analysis. Inclusion of the testify item on the belief in accuracy LV did not notably affect model fit: χ^2 (179) = 467.79, CFI = .982, SRMR = .053, RMSEA = .041 (.037, .046). The item was retained because this item better incorporates Rubin and colleagues' preceding work into the current framework. The new 'complete' item did not load on these factors and was not retained. See Fig. 1 for a graphical depiction of this final structural

[4] Modelling all 988 participants with a valid childhood event did not reveal any notable differences in estimated item loadings, LV correlations, or path coefficients, compared to the models that used 933 participants.

model, including item loadings and correlations between the LVs.

Having finalized the stability of the structural model, we added the covariates to the model. Single item covariates in this model included perceptual detail and personal plausibility. The reliving and mental time travel items were loaded onto a re-experiencing latent variable (α = .84). The spatial detail and setting items were loaded onto a spatial latent variable (α = .82). The covariates were allowed to correlate in the model. See Table 4 for the resulting estimates. The relationships between the predictors and LVs were similar to Study 1. First looking at the path coefficients, autobiographical belief was strongly predicted by plausibility, and plausibility did not predict the other LVs. The recollection and belief in accuracy LVs were predicted strongly by perceptual detail, and moderately by re-experiencing. In this study setting predicted all three LVs to a similar, moderate degree. The estimated correlations between the covariates and the LVs mirrored this pattern. Personal plausibility shared substantial variance with belief in occurrence, but not the other LVs, for both events.

There was one notable difference in this pattern between the two events. Personal plausibility was a stronger predictor of (coefficient .68 vs. .42) and shared more variance with (R^2 .53 vs. .24) autobiographical belief for the uncertain than for the childhood event. This suggests that people rely on plausibility to a greater extent when not certain about autobiographical events.

The uncertain event was included to provide another type of memory to assess the model fit, and to provide another method of examining any implications of near-ceiling effects for the indicators of autobiographical belief. Fig. 2 presents mean levels for the constructs across both events, confirming that the ratings were lower for the uncertain event. The invariance in measurement between the two events also indicates that the exploratory model was not affected by high autobiographical belief ratings for the earlier events. The fact that cueing for an uncertain event results in obtaining events with overall lower autobiographical belief ratings is important, in light of concerns that cues often result in the retrieval of events that are associated with high levels of both autobiographical belief and recollection (Scoboria & Talarico, 2013).

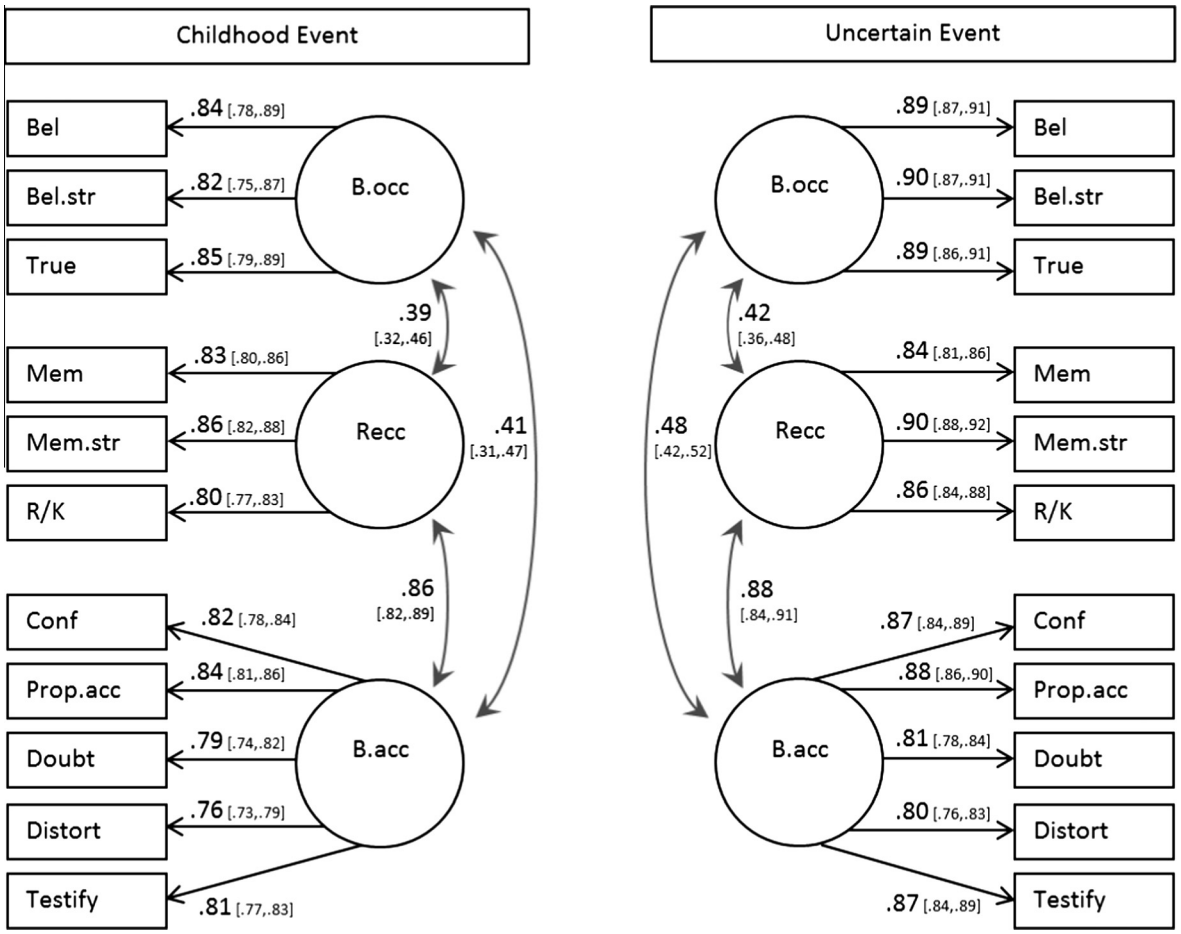

Fig. 1. Study 2, final structural model. Both of the events are modelled simultaneously. Bias corrected 95% confidence intervals are reported for item loading and latent variable correlations. B.occ: Belief in occurrence LV; Recc: Recollection LV; B.acc: Belief in accuracy LV.

Table 4
Study 2, standardized path coefficients when predicting the latent variables, by event.

Event	Covariate	Latent variable					
		Recollection		Belief in occurrence		Belief in accuracy	
		Path coefficient[a]	R^{2}[b]	Path coefficient	R^{2}	Path coefficient	R^{2}
Childhood event	Perceptual detail	**.38 [.26, .51]**	.32	**.16 [.05, .30]**	.11	**.38 [.25, .48]**	.34
	Setting[c]	**.25 [.09, .41]**	.11	**.22 [.05, .39]**	.01	**.26 [.13, .40]**	.11
	Re-experiencing[d]	**.20 [.12, .30]**	.09	**−.14 [−.22, −.07]**	.00	**.21 [.12, .29]**	.09
	Personal plausibility	.05 [−.02, .11]	.05	**.42 [.32, .53]**	.24	.06 [−.01, .12]	.05
Uncertain event	Perceptual detail	**.45 [.34, .55]**	.39	.09 [−.02, .17]	.09	**.37 [.27, .45]**	.34
	Setting[c]	**.26 [.14, .38]**	.10	**.16 [.05, .28]**	.00	**.35 [.24, .47]**	.13
	Re-experiencing[d]	**.15 [.05, .24]**	.09	**−.12 [−.21, −.05]**	.00	**.10 [.02, .19]**	.07
	Personal plausibility	.02 [−.03, .08]	.04	**.68 [.62, .73]**	.53	**.10 [.04, .16]**	.09

Note: Estimated path coefficients from the SEM model simultaneously predicting the three latent variables for each of the two events.
[a] Model with standardized path coefficients between covariates and the LVs; covariates treated as predictors of the LVs.
[b] Model with correlations estimated between covariates and the LVs.
[c] Setting was entered into the model as a latent variable with two indicators (space, setting).
[d] Re-experiencing was entered into the model as a latent variable with two indicators (reliving, mental time travel). 95% confidence intervals in brackets are based on 1000 bootstrapped samples. Path coefficients that do not include zero in the interval are in bold.

7. General discussion

This research demonstrates that recollection, autobiographical belief, and belief in the accuracy of recollective mental representations are distinct metamemory appraisals that contribute to the remembering of autobiographical events. While existing theories agree that recollection is a central component of remembering, this work indicates that theories emphasizing appraisals of accuracy (Rubin, 2005; Rubin, 2012) and appraisals of occurrence (Mazzoni & Kirsch, 2002; Scoboria et al., 2004; Scoboria et al., 2014) are complementary. These studies validate that a number of the distinct features of autobiographical memory (AM) articulated by Brewer (1996) are independent.

This research adds to the body of work which shows that belief in the occurrence of events is distinct from the recollection of events. Similar to preceding studies, their indicators were different, estimated correlations between the two were no greater than modest, and a number of their predictors were distinct. Recollection indexes the appraisal that a current mental experience is reflective of a prior episode of experience. Recollection has long been described as having the key components of perceptual imagery and an associated sense of re-experiencing (James, 1890/1950; Tulving, 1985). Evidence has emerged which supports the assertion that recollection is distinguished from other forms of mental simulation (e.g., simulating future events) by the presence of the sense of re-experiencing the past (Addis et al., 2009). These studies provide further evidence that perceptual imagery and re-experiencing are central to recollection.

Belief in occurrence is an appraisal of the truth status of events, regardless of the degree to which recollection is present. Scoboria et al. (2014) argue that recollection is a key contributor to autobiographical belief appraisals, such that when recollection is strong, autobiographical belief is often rapidly inferred. But sometimes strong recollection is discrepant with other information about events, resulting in a weighing of evidence to arrive at decisions about the truth status of events. Event plausibility is consistently associated with autobiographical belief appraisals in this and preceding work. Thus autobiographical belief judgments are contingent on viewing events as ontologically possible, both in terms of what is possible in the world and what is viewed as possible for oneself in the past. Event plausibility plays an important gating function by preventing the processing of events that are 'impossible' (Odegard & Lampinen, 2006; Scoboria, Mazzoni, Jarry, & Shapero, 2012). A new finding in the second study is that plausibility is more strongly predictive of autobiographical belief when memories about which individuals are somehow uncertain are assessed. In other words, when recollection is experienced as unreliable individuals rely on other sources of information to appraise the truth status of events.

Newly established here is that belief in occurrence and belief in accuracy are likewise distinct. Each emerged as a distinct latent variable in the confirmatory modelling process, correlations between the two were moderate in magnitude, and the covariates differentiated the two. Such a distinction aligns well with the view that autobiographical belief judgments are sometimes made in the presence of strong and compelling episodic mental imagery, at other times in the presence of lower quality episodic imagery, and still at other times in the absence of any mental imagery. Belief in accuracy judgments are appraisals of the quality of the episodic image – to what extent are the details within the representation associated with the event an accurate reflection of a prior state of affairs. This distinction leads to the conclusion that it is possible to edit the details within a memory without altering the overarching autobiographical belief appraisal. For example, two people might agree that an event occurred at a particular time and in a particular place, but disagree as to some of the within-event details such as who did what. It is also possible to reattribute the source of an event without any alteration to the view that the event is being recalled accurately. Examples of such cases have been discuss in the literature on nonbelieved memories (Scoboria et al., in press). A person may describe a vivid memory of an event, in response

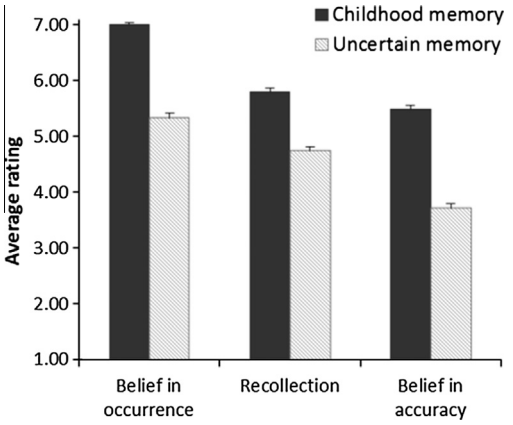

Fig. 2. Study 2, average ratings for each of the latent variables by memory cue. Bars show 95% confidence intervals on the means.

to which another person states that the event did not happened to them. Sometimes the other person is correct, and the rememberer also decides that the other person is correct and relinquishes autobiographical belief for the memory. However, at the same time the other person may agree that the mental representation is a quite accurate description of what occurred in the event. Hence the event is recalled with good accuracy, but is associated with a source monitoring error as to whom the event in fact occurred. For a recent theoretical view on the relationship between belief in occurrence and source monitoring attributions, see Nash, Wheeler, and Hope (in press).

The fact that predictors related to imagery loaded on the belief in accuracy LV and the high correlation between the belief in accuracy and recollection LVs further support the notion that belief in accuracy reflects monitoring of the accuracy of recollected images, as proposed by Rubin (2005). Recollection appraisals arise out of the results of the processes reflected in belief in accuracy appraisals. In the more general terms proposed by Nelson and Narens (1994), metacognitive monitoring processes (belief in accuracy) serve to evaluate and control the output of other cognitive systems (recollection). This points to the value of pursuing further linkages between the study of episodic and autobiographical memory and the more general memory monitoring literatures. To accomplish this, further theorizing and empirical work as to the monitoring of whole events vs. details within events is needed. The relationship between confidence in individual event details (measured in much of the work on memory and metacognition) and overarching accuracy appraisals for whole events are unknown at this time. If automatic appraisals of autobiographical memory are global and the default assumption is to believe the contents of memories, then drawing attention to event components is likely to decrease belief in accuracy judgments. As each detail is met with scepticism, the accumulated belief value can only diminish.

This distinction between appraisals for events and items within events raises new questions as to how findings in the literatures on misinformation, interviewing about witnessed events, and questioning about details within scenes depend on the interviewee being completely certain that the event itself occurred. In the typical misinformation study, there is little doubt for participants that the event has been witnessed. Thus the focus of such studies is on how misinformation influences the recall of details within events. Appraisals for the details of events for which autobiographical belief is high may be quite different than memory for the details of events for which autobiographical belief is lower. For example, one might expect differences in recall between someone who knows that they are witnessing a crime as it occurs vs. another person who was in the vicinity and is later uncertain if they saw the crime. Studies that are directed at memory for details (e.g., items on lists, contents of rooms, details in scenes) may have more to do with micro-level, within-event processes than they do with overarching event-related processes. As Scoboria et al. (2014) note, belief in occurrence and belief in accuracy are likely confounded when single items are the target of study. Research methods that examine single items in isolation may tell us little about the recollection of whole events or the relationships among details within events.

Two notes as to the inclusion of predictors of the latent variables in this model are warranted. First, a number of the items that we use as predictors of recollection and belief in accuracy are assumed to be measures of these constructs in other work (e.g., Fitzgerald & Broadbridge, 2012). We treat them as predictors because this approach more closely mirrors Rubin's (2006) argument that distinct component processes contribute to the overarching metacognitive judgments that are modelled in this research. For example, the strength of visual imagery is one of a number of inputs that has a direct influence on appraisals of recollection. Second, we emphasize that the goal of this work was to establish whether memory reports included distinct belief in occurrence, recollection, and belief in accuracy components. The main finding of these studies arises from the structural modelling which shows the measurement distinction and estimates the correlation between the resulting latent variables. The predictors included in this work were selected to partly illuminate the distinction, and are not intended to be comprehensive. Further work is needed to flesh out the model in order to identify how different theorized constructs relate to the constructs identified herein. More comprehensive measurement of the mental simulation of events clearly requires attention. Notions of the coherence of narratives and remembering as storytelling will need to be incorporated (Rubin, 2006). Issues of identity centrality and the personal impact of events need to be considered (Berntsen & Rubin, 2006; Brown, Hansen, Lee, Vanderveen, & Conrad, 2012), particularly in relation to autobiographical belief processing. The widely documented influences of a variety of social processes on these constructs require elucidation (Drivdahl & Hyman, 2014; Hirst & Echterhoff, 2012; Pillemer, 1998). The efforts to predict the key latent variables demonstrated in this work have only just begun, and we look forward to future work that examines additional predictors of the factors discussed here.

A possible process for remembering an autobiographical memory is to assess the plausibility of a cue, arrive at

a decision regarding belief in the occurrence of the event, engage in further efforts to retrieve the details of that event, formulate a perceptual representation of the event, and then evaluate the accuracy of this representation. The sequence of these steps need not be in a fixed order, and may occur in parallel. What seems clear is that for an event to be labeled as recollected, sufficient information must be present to produce a representation that is viewed to be sufficiently accurate. What is becoming equally clear is that decisions about event occurrence happen in the absence of recollection, and in some cases, in contradiction to recollection. We look forward to future theorizing in which the parameters of decision making about the occurrence and accuracy of autobiographical events are more fully articulated.

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Appendix A

Items contributing to the latent variables.
Autobiographical belief/belief in occurrence items:

1. *ABMQ belief*. How likely is it that you personally did in fact experience this event? (1 Definitely did not happen; 8 definitely happened).
2. *Belief strength*. How strong is your belief that this event actually occurred? (1 No belief; 3 weak belief; 5 Moderate belief; 7 strong belief).
3. *True event*. It is true that this event occurred. (1 Not at all true; 7 completely true).

Recollection items

1. *ABMQ memory*. Do you actually remember experiencing the event? (1 No memory at all; 8 clear and complete memory).
2. *Memory strength*. How strong is your memory for this event; (1 No memory; 3 weak memory; 5 moderate memory; 7 strong memory).
3. *Remember/know*. As you think about this event, can you actually remember it rather than just knowing that it occurred? (1 Not at all; 3 vaguely; 5 distinctly; 7 more than any event).

Belief in accuracy items

1. *Confidence*. How confident are you that your memory for this event is accurate? (1 Not at all confident; 7 completely confident).
2. *Proportion accurate*. What proportion of your memory for this event is accurate? (1 Not at all accurate; 7 100% accurate).
3. *Distorted*. To what extent is your memory of the event distorted, rather than being an accurate reflection of the event as a neutral observer would report it? (1 100% distorted; 7 100% accurate).
4. *Doubts*. Do you have any doubts about the accuracy of your memory for this event? (1 A great deal of doubts; 7 no doubts whatsoever).
5. *Testify*.[5] Would you be confident enough in your memory of the event to testify in a court of law?

(1 Not at all; 3 vaugely; 5 distinctly; 7 as much as any event).

Appendix B. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.cognition.2014.11.028.

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