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The Role of Interest in Memory for Trivia Questions: An Investigation With a Large-Scale Database

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The importance of interest for memory performance has been established in previous studies. One way to induce interest in experiments is to use trivia questions. However, previous studies have used only a limited number of trivia questions and these questions differ substantially across studies, making it difficult to ensure the comparability and generalizability of the findings. Most of these studies also have not differentiated between interest in the trivia question itself and interest in the corresponding answer. To address these issues, the current study established a normative database for 244 trivia questions with a large sample (N = 1,498) and examined how pre-answer interest (i.e., interest in the question) and post-answer interest (i.e., interest in the answer) relate to learning performance. Participants were presented with trivia questions, asked to provide their best guess for the answer, rated their confidence in the guess, and indicated their interest in learning the true answer. Following the presentation of the answer, participants indicated their post-answer interest. One week later, participants were given a memory test on the questions. A multilevel structural equation model revealed that the positive relationship between pre-answer interest and memory was mostly mediated by post-answer interest (i.e., interest in the questions' answer). Confidence had both a direct and a mediated effect (over interest) on memory. These results provide a more fine-grained analysis of how interest can fuel learning.

Keywords: epistemic emotions, memory consolidation, hypercorrection, metacognition

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The trivia question database can be found on our lab's website: http://koumurayama.com/resources.php

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[1] The precise definition of interest varies across researchers. Within the literature, the differences between interest and curiosity are also controversial, with some arguing for shared and some others arguing for differential mechanisms of these constructs (for a review, see Grossnickle, 2016). Our paper is not aimed to provide a precise definition of interest and curiosity. Rather, our focus is to examine motivational processes underlying the knowledge acquisition process. For that reason, our terminologies are rather tentative but not definitive ones. We also try not to use the term *curiosity* as much as possible given the difficulty in defining this term separately from interest (Grossnickle, 2016). See General Discussion for more detailed arguments about these terminologies.

Interest is a motivational variable that is characterized as a positive feeling toward, knowledge of, and valuefor a specific object (Schiefele, 2009).[1] Interest has shaped human life throughout history: Without asking "Why?" many important discoveries would not have been made. Ball (2013) points out that the lift of the Christian banishment on human interest, for instance, was a crucial factor in prompting the scientific revolution in the 17th century. In the Dark Ages, interest was seen as a vice and the thriving for either unnecessary or forbidden knowledge. It was only after scientists, like Newton and Copernicus, who fought against the taboo and ignited a curious euphoria through the Western world that we observed an increasing number of scientific discoveries. On a smaller scale, interest is also a powerful motivator in daily life. For example, interest can make the effortful seem effortless in educational settings (Dewey, 1913). Interest can also help us persevere when we might otherwise have given up (Pallak, Costomiris, Sroka, & Pittman, 1982; Weiner, 1980).

Interest and Memory

The current study focuses on one crucial aspect of interest—the facilitative effects of interest on memory performance. People intuitively agree that interest facilitates our memory performance: We tend to remember the things in which we are interested in and, indeed, this idea is not new. For example, Berlyne (1954b) argued that the satisfaction of interest would lead to the enhanced learning of study materials. Over the years, a huge body of research on text comprehension in educational psychology has been conducted to show that interesting texts are more memorable (see Hidi, 2001, for a review). Interesting texts (e.g., Anderson, Shirey, Wilson, & Fielding, 1984; Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Harp & Mayer, 1997) as well as texts on topics that interest us lead to greater learning (e.g., Anderson, 1982; Estes & Vaughan, 1973; Hidi, Baird, & Hildyard, 1982; Wade, Buxton, & Kelly, 1999). This learning has also been shown to result in deeper text-comprehension and better integration of the topics read (Krapp, 1999; Schiefele, 1996, 1998; Schiefele & Krapp, 1996). A typical approach of these studies is to record people's interest in individual texts and/or the general subject of the texts and examine consequent memory performance. They generally find that people better remember the texts in which they are interested than the text in which they are not. For example, Schraw, Bruning, and Svoboda (1995) presented participants with a short text and measured their perceived interest in it. The study found that perceived interest is positively related to later recall of the text.

These studies provide important insights about the power that interest has over learning and shows that the effect of interest on memory is well-established. However, given the complexity of text materials, this text paradigm is unclear about the specific motivational mechanisms through which interest helps us learn. One potential mechanism is that people strive to fill knowledge gaps for unknown information. While reading a text, for example, students may voluntarily develop questions of their own about the topic of the text (see also Johns & McNamara, 1980 and Kintsch, 1998 for the importance of generating questions in text reading). These (both internally and externally) generated questions should invoke interest as students become aware of gaps in their knowledge (Loewenstein, 1994). This is important because it is possible that interest for unknown information motivates people to activate relevant knowledge in the semantic network as they search for the answer, resulting in better integration of new information within the associated framework. Indeed, Hays, Kornell, and Bjork (2013) showed that attempts to retrieve an answer to a test question activates a related knowledge network and enhances memory for the answer in comparison to memory for untested items. This learning mechanism should be present in reading text materials to some extent, but previous studies using text materials are unable to specifically examine this aspect of the interest-memory relationship.

Another limitation of text materials is an inability to differentiate the effects of situational interest from individual interest. In their four-phase model of interest development, Renninger and Hidi (Hidi & Renninger, 2006; Renninger & Hidi, 2016) distinguished between situational and individual interests. Situational interest describes interest in response to external factors and is often only held for a short period. With repeated engagement in an activity, how-

ever, people internalize the value for the activity and develop individual interest. In light of this model, interest assessed via text paradigms may reflect both situational and individual interests. Participants may report interest in a text because they are briefly stimulated by the contents of the text (situational interest), but it is also possible that reported interest reflects participants' valuation of the topic (individual interest) which they held and potentially strengthened while reading the long text.

Trivia Question Paradigm

The role of interest in learning and memory has received recent attention from different lines of research—especially from the memory literature in cognitive psychology and neuroscience (Gruber, Gelman, & Ranganath, 2014; Kang et al., 2009; Marvin & Shohamy, 2016; McGillivray, Murayama, & Castel, 2015). It is important to note that these researchers typically utilize "trivia questions" with a question–answer format. This paradigm—in which participants are presented with a series of trivia questions which could trigger their interest—can specifically investigate how interest triggered by knowledge gaps (i.e., interest in the answer) facilitates memory of the answer. Trivia questions also have an advantage in that, in comparison to texts (Harp & Mayer, 1997), they are very short and have much less real-life value—a core facet of individual interest, allowing us to examine people's momentary situational interest in a relatively straightforward manner. Another advantage is that trivia questions and their answers can be considered as cue-target pairs in memory research, allowing us to apply common experimental paradigms used in the field (e.g., Kornell & Bjork, 2009; Vaughn, Hausman, & Kornell, 2017). Using trivia questions, these studies consistently found that interest in knowing the answer is positively related to memory performance—especially after a delay—for people of various ages (Gruber et al., 2014; Kang et al., 2009; McGillivray et al., 2015; Marvin & Shohamy, 2016; Mullaney, Carpenter, Grotenhuis, & Burianek, 2014; Murayama & Kuhbandner, 2011). This line of work is primarily motivated by recent findings in cognitive neuroscience that interest activates the so-called "reward network" in the brain, including the ventral striatum and the midbrain (Gruber et al., 2014; Kang et al., 2009). As activation in the reward network increases phasic dopamine release in the hippocampal memory system (Düzel, Bunzeck, Guitart-Masip, & Düzel, 2010; Lisman & Grace, 2005; Shohamy & Adcock, 2010), researchers theorize that this mechanism underlies how interest enhances memory performance.

These recent studies using trivia questions have provided great insights into the relationship between interest and memory. However, one important limitation is that there is no established common trivia item pool to induce interest. In previous studies, questions have always been prepared in an ad hoc manner, and different research teams use different sets of trivia questions. Accordingly, the amount and range of interest that trivia questions induce is unclear, and it is difficult to compare the results between different studies. In addition, most of the work on interest uses a fixed set of a small number of trivia questions (typically 40–60). The use of a fixed set items can inadvertently produce item effects (Murayama, Sakaki, Yan, & Smith, 2014; Westfall, Judd, & Kenny, 2015) and/or item selection effects, which not only limits the generalizability of the findings, but also leads to potentially misleading results and conclusions. This is especially important in the context of interest research because research on interest has commonly used items (rather than participants) as the unit of analysis (i.e., intraindividual analysis; see Hamaker, Dolan, & Molenaar, 2005; Murayama et al., 2017). Previous studies show that—unless appropriately controlled in statistical analysis—item effects have non-negligible influence on statistical inference in such intraindividual analysis (Murayama et al., 2014). Also in light of the recent general concern about the reproducibility of psychological research (Open Science Collaboration, 2015), establishing a standardized or rich trivia question item pool is an important step (see also Sochat, Eisenberg, Enkavi, Li, & Bissett, 2016) to promoting transparent, robust, and reproducible research on interest and memory.

Another limitation of the studies investigating interest using trivia questions is that they do not make a strong distinction between the state of interest before and after the answer is presented. We tentatively call them pre- and post-answer interest. We view pre- and post-answer interest as distinct stages of a motiva-

tional process in the knowledge acquisition process. For example, when participants are presented with a question "What product is second, only to oil, in terms of the largest trade volumes in the world?" they may feel a desire to know the answer; this motivation to seek relevant information represents pre-answer interest. Once the answer (coffee) is provided, participants may feel positive emotions, which can be denoted as post-answer interest ("how interesting the answer is!"). In other words, pre-answer interest represents the feeling of becoming aware of a knowledge gap (Loewenstein, 1994), whereas post-answer interest represents the feelings produced by the satisfaction of the knowledge gap and the positive feelings toward the gained information. These two subjective states are similar and clearly related, but it is possible that the initial pre-answer interest is dissociated with post-answer interest (e.g., "I was interested in the question, but the answer disappointed me"). To better evaluate the work on pre-answer interest in the face of the existing literature on interest and memory, a better understanding of the relation between pre- and post-answer interest is needed.

To our knowledge, McGillivray et al. (2015) is the only study that distinguished between these constructs and examined the differential prediction of memory performance in younger and older adults. In this study, pre-answer interest is called curiosity (the difference between curiosity and interest will be discussed in General Discussion). The study ($N = 24$ each for younger and older adults) presented participants with 60 trivia questions; participants were asked to guess the answer to the question, indicate their confidence in the guess, and rate their curiosity (pre-answer interest) about the true answer. After being presented with the answer, participants indicated their (post-answer) interest in the real answer. When both pre-answer and post-answer interest were included in the same regression model, only post-answer interest predicted memory for questions that were initially answered incorrectly. This pattern was consistent for both younger and older adults, and both in immediate and delayed memory performance. These findings suggest that pre-answer and post-answer interest should be distinguished to understand learning processes, but more fine-grained analysis with a larger sample size is needed to further disentangle the predictive value of these two similar, but distinct, constructs.

One potentially interesting possibility is that pre-answer interest elicited by the presentation of trivia questions enhances memory performance, but this relationship is mediated by increased interest *after* the presentation of the answer (see Pekrun & Perry, 2014, for a similar model in the literature of educational psychology). Thus, post-answer interest may be a proximal predictor of memory performance and that other factors which influence post-answer interest can promote memory performance independently of pre-answer interest. For example, several studies using trivia questions have assessed participants' confidence in their answers (Kang et al., 2009; McGillivray et al., 2015). Although these studies did not show a clear relationship between confidence and memory for the answers, interest is often activated by unexpected negative feedback (Renninger & Hidi, 2016; i.e., realizing that your answer is wrong when you were actually confident with the answer); it is possible that confidence is a remote predictor of memory performance mediated by post-answer interest. Previous research has shown that a high confidence error promotes people's memory performance (e.g., Butterfield & Metcalfe, 2001; Metcalfe & Miele, 2014). This "hypercorrection" effect (Butler, Fazio, & Marsh, 2011) may be caused by increased interest in the answer due to the unexpected error.

Current Study

The current study has dual purposes. One purpose is to establish a large, standardized item pool of trivia questions that is especially suitable to investigating the distinction between pre-answer and post-answer states of interest, with the ultimate aim being to promote the comparability and reproducibility of future research on interest and learning. For that purpose, we collected a large pool of trivia questions and presented these trivia questions to a large number of participants. Participants rated the extent to which these questions elicited their pre-answer interest, post-answer interest, and confidence. Partici-

pants also took a (surprise) memory test after an approximately 8-day delay, providing an objective measure of learning. The trivia questions and the summary data are freely available online on our lab's website. We also conducted some exploratory analyses (e.g., analysis with variance decomposition) to further examine the characteristics of these normative ratings.

Another purpose of the current study is to clarify the relationship between pre-answer interest, confidence, post-answer interest, and (long-term) memory performance. In the obtained data sets, we assessed all of the information at once to provide a more detailed analysis of these variables and their relationship to each other. With a large sample size and a large number of trivia questions, we can also better ensure the generalizability of the findings. As indicated earlier, we expect pre-answer interest to be positively related to memory performance but that this relationship is mediated by post-answer interest. In addition, confidence may also influence memory performance (i.e., hypercorrection effect), but this relationship should also be mediated by increased post-answer interest.

Method

Participants

We recruited participants from the United States through Amazon.com's Mechanical Turk. The experiment consisted of two separate sessions held at least one week apart (see Procedure). Participants received $1 in exchange for their participation in the first session and obtained an additional $1 by participating in the second session. Prior to data analysis, we checked and excluded participants (a) who reported problems during the online presentation of the experiment or indicated that they did not follow the instructions, (b) who mistakenly started the second session before we emailed an invitation to the second session, (c) who accidently participated twice, or (d) who had participated in a similar experiment with trivia questions before (as measured by self-reports). This led to the exclusion of 5.3% of participants, resulting in a final sample of 1,898 participants (61.5% female; 37.4% male; 1.2% unspecified). The average age was 36.76 years (SD = 12.15). The majority of the participants identified as Caucasian (84%); 6% as African American; 5% as Asian/Pacific Islander; 1% as American Indian/Alaskan Native; and 3% as "others/unknown." 1% did not report their ethnicity at all. Of the full sample, 1,498 participants (79%) took part in the second session (62.4% female; 36.4% male; 1.1% unspecified; M_{age} = 37.2, SD_{age} = 12.14).

Materials

We generated a pool of 303 trivia questions along with their answers from Kang et al. (2009); Nelson and Narens (1980); Gruber et al. (2014), and other online resources (e.g., "What is the only planet in the solar system that rotates clockwise?" "Which company is the largest manufacturer of tires?"). To ensure variability within the database, we sought to collect trivia questions from a variety of domains that might elicit pre-answer or post-answer interest to different extents. We did not, however, include trivia questions in the pool if (a) the answer consisted of more than 2 words, (b) the answer contained an unfamiliar proper noun that could be difficult to remember (e.g., Aconcagua), (c) the question and/or answer was obviously cultural or age specific, or (d) the answer was the same as that of another trivia question in the pool.

Procedure

The experiment was run in two separate sessions. It was created using Collector, a PHP-based open-source program for creating experiments online (Garcia & Kornell, 2012–2015). In the first session, we presented 66 questions from the item pool to participants which were randomly sampled for each participant. This item sampling procedure not only prevents fatigue caused by lengthy tasks, but also effectively eliminates possible bias resulting from item effects (Murayama et al., 2014; Westfall et al., 2015). Trivia questions were presented in a random order. For each trial (see Figure 1), a trivia question was presented and participants typed an answer to the question in a text box (the text box appeared 2 s after the presentation of the trivia question). Participants were encouraged to report their best guess when they did not know the answer but were told that they could leave the field blank if they could not

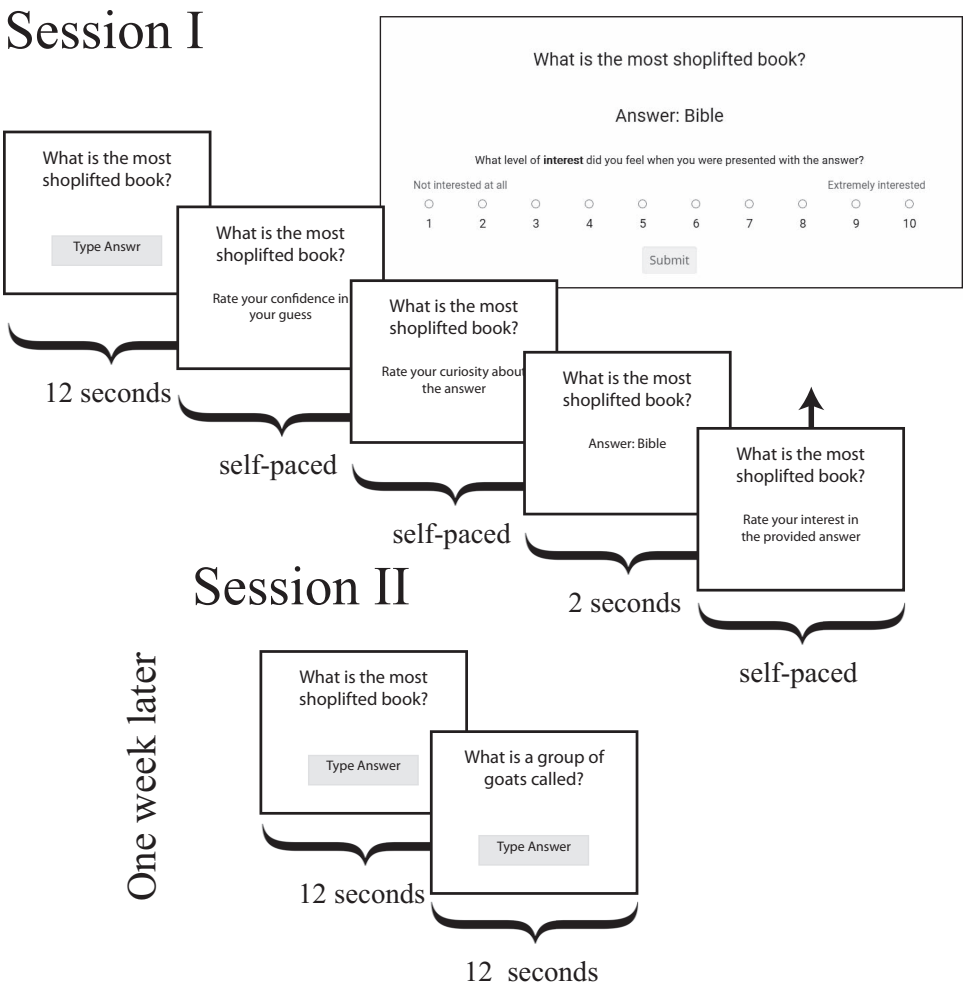

Figure 1. Experimental procedure.

come up with any answers. Once participants pressed the submit button (or did not provide an answer within 12 s), they were asked to rate their confidence in their answer ("How confident are you that you know the correct answer?") and pre-answer interest in learning the question's answer ("How curious are you about the answer?") on a scale from 1–10, with 1 indicating "not confident/curious at all," and 10 indicating "extremely confident/curious." Immediately after these ratings participants were shown the correct answer for 2 s, after which participants were asked to indicate their interest level ("What level of interest did you feel when you were presented with the answer?"). Again, interest ratings were on a scale from 1–10, with 1 indicating "not interesting at all," and 10 indicating "extremely interesting." The trivia question was displayed throughout the trial (see Figure 1) to ensure that participants correctly remembered the trivia question when they provided an answer or ratings.

The second session took place about one week after the first session (M = 8.34 days, SD = 2.19, range = 7–37). Participants were emailed an invitation to the second session with a link to the experiment six nights after their participation in the first session. In this second session, participants were presented with the same set of questions that they had rated in the first session and were asked to recall the answer to the question

within 10–12 s. The questions were presented in a random order.

Data Cleaning and Coding

The accuracy of participants' answers was determined jointly by a built-in computer program and one research assistant; Greta M. Fastrich then checked the consistency of coding for all the answers. It was found that 12% of trivia questions had the accuracy rate of more than 50% in the first session. Because we were interested in participants' pre-answer interest and memory accuracy for the trivia questions to which participants failed to provide a correct answer, we excluded these items from the analysis. In our preliminary analysis, we also found that answers consisting of numbers had a substantially different pattern of correlations; thus, we excluded these questions. This screening procedure resulted in the final set of 244 trivia questions (see Appendix A) for the main analysis.

In the data, 3% of the trials (presentation of a question in combination with ratings and memory data from the second session, if available) were excluded due to technical difficulties. In addition, we excluded the 15% of the trials which had already been answered correctly during the initial test in the first session. Consequently, the final data set contains an average of 41.71 trials (min = 9; max = 57) per participant. Each question was represented by an average of 327.89 trials (SD = 52.65; min = 193; max = 424). The decisions about all of these exclusions were made prior to the main data analysis, and R (Version 3.3.2; R Core Team, 2016) was used for data cleaning. The 244 trivia questions used in the final data set and their descriptive statistics (e.g., mean pre-answer interest ratings for each item) are publicly available on our lab website.

Results

Table 1 reports the descriptive statistics of the main variables. We report two types of SDs: one using participants and the other using items as the unit of computation. On average, participants reported relatively low confidence (M = 2.79; $SD_{participants}$ = 1.16; SD_{items} = 0.84) in their answers (note that we excluded the trials with correct answers), and relatively high pre-answer interest to questions (M = 6.75, $SD_{participants}$ = 1.93; SD_{items} = 0.44) and post-answer interest in the answers to the questions (M = 6.67; $SD_{participants}$ = 1.86, SD_{items} = 0.56). Females reported higher overall pre- and post-answer interest, but less overall confidence in their answers (*Pre-answer interest:* M_{Female} = 7.84; SD_{Female} = 2.19; M_{Male} = 7.48; SD_{Male} = 2.30; $t_{Pre\text{-}Interst}$ (1,874) = 3.43, $p < .01$, Cohen's d = 0.16; *Post-answer interest:* M_{Female} = 7.49; SD_{Female} = 2.17; M_{Male} = 7.18; SD_{Male} = 2.17; $t_{Post\text{-}Interest}$ (1,874) = 2.99, $p < .01$, Cohen's d = 0.14). The sample exhibited a wide range of age groups (see Methods) but, consistent with McGillivray et al. (2015), age did not correlate with individual differences in overall memory accuracy (r = .01). Overall pre- and post-answer interest ratings increased with age, rs = .16 and .18, ps < .01. Overall confidence ratings also significantly correlated with age, but the magnitude of the correlation was weaker, r = .09, $p < .01$. Memory performance did not correlate with the time interval between sessions (r = −0.04).

Correlations

Within-person correlations between the variables were estimated using the maximum likelihood method via MPlus (Version 7.1.1;

Table 1
Descriptive Statistics of Confidence, Pre-Answer Interest, Post-Answer Interest, and Memory Ratings

			Between participants		Between items	
Variable	M[a]	N	SD	Range	SD	Range
Confidence	2.79	1898	1.16	1.00–9.86	0.56	1.47–5.31
Pre-answer interest	6.75	1898	1.93	1.00–10.00	0.44	5.45–8.05
Post-answer interest	6.67	1898	1.86	1.00–10.00	0.56	5.23–8.14
Memory accuracy	0.36	1498	0.17	0–0.97	0.19	0.02–0.92

[a] Averaged across participants.

Muthén & Muthén, 1998–2012). Consistent with the literature of the hypercorrection effect (see Butterfield & Metcalfe, 2001), confidence (in the answers that participants failed to produce) was positively (but weakly) related to memory accuracy, $r = .108$, $p < .01$, indicating that high-confidence errors were related to better memory performance. As expected, both pre-answer interest, $r = .101$, $p < .01$ and post-answer interest, $r = .158$, $p < .01$, were positively related to memory accuracy, providing additional evidence for the facilitative effects of pre- and post-answer interest on memory performance. These relationships were somewhat weak, but consistent with the previous literature that reported similar statistics (McGillivray et al., 2015). Confidence and pre- and post-answer interest were also positively correlated. Confidence showed positive but weak correlations with both pre-answer interest, $r = .134$, $p < .01$, and post-answer interest, $r = .153$, $p < .01$. The correlation between pre- and post-answer interest was moderate, $r = .530$, $p < .01$, suggesting that interest in knowing the answer and the perceived interest after seeing the answer have some shared variance. Table 2 provides an overview of the within-person correlations.

Variance Decomposition

When a participant finds a trivia question interesting, there are three possible sources of influence. First, this trivia question may be generally interesting to all participants ("item effect"). Second, this participant may tend to rate all trivia questions as interesting ("participant effect"). Third, this participant may find this trivia question particularly interesting due to his or her specific preference ("item-by-participant interaction effect"; this also includes measurement errors). Loewenstein (1994) suggested that there are substantial individual differences in what people find interesting, indicating large item-by-participant interaction effect, but this idea has not been tested empirically by previous studies using trivia questions. To address this question, we conducted a mixed-effects modeling analysis on the data (with maximum-likelihood estimation to account for the imbalanced structure of the data), which allowed us to decompose the variances due to the item effect, participant effect, and the interaction between item and participant effects.

Table 3 reports the % of the variance explained by each of the effects in pre- and post-answer interest ratings. Consistent with expectations, about 45% of the variance in the data can be explained by the item-by-participant interaction in both interest ratings (pre-answer interest: 45.0%; post-answer interest: 45.4%), suggesting individual differences in pre- and post-answer interest across trivia questions, although some of these individual differences may simply reflect random error variance. Participant effect accounts for a large proportion of the variance (pre-answer interest: 52.6%; post-answer interest: 50.3%). This finding may reflect large individual differences in the general tendency to react to these trivia questions or mere response bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). It is interesting to note that the item effect explained a much smaller proportion of variance in the data (pre-answer interest: 2.4%; post-answer interest: 4.3%).

We then computed the reliabilities ($E\rho^2$) of averaged ratings of participants in pre- and post-answer interest to discriminate the relative differences between items. The reliabilities provide a measure of estimation accuracy. High reliability indicates that the averaged ratings are very likely to reflect the true values (in the population). This was done by applying the formula provided by Brennan (2001) as follows:

$$E\rho^2 = \frac{\widehat{\sigma_l^2}}{\widehat{\sigma_l^2} + \frac{\widehat{\sigma_{lp}^2}}{n_p}}$$

where $\widehat{\sigma_l^2}$ and $\widehat{\sigma_{lp}^2}$ are the estimates of item variance and the variance of the Participant × Item interaction, and n_p is the number of participants. As Table 3 indicates, the estimates of the reliability coefficients are substantially large (>.95). These results indicate that, although item variance is relatively small in participants' ratings of trivia questions, the average ratings from a large sample of participants ($N = 1{,}898$) exhibit sufficient reliability to discriminate the pre- and post-answer interest between the items.

Table 2
Correlations Between the Variables of Confidence, Pre-Answer Interest, Post-Answer Interest, and Memory Accuracy

Variable	1	2	3	4
1. Confidence	—	.134	.153	.108
2. Pre-answer interest	.134	—	.530	.101
3. Post-answer interest	.153	.530	—	.158
4. Memory accuracy	.108	.101	.158	—

Note. All correlations reached statistical significance with one-sample t tests ($p < .01$).

Classification of Trivia Questions

Figure 2 represents the scatter plots of the average pre-answer interest, confidence, and post-answer ratings of the 244 trivia questions. Consistent with the correlation analyses, these three variables are positively related in the scatter plots. It should be noted, however, that the scatter plots exhibit stronger relationship between the variables than what is indicated in the correlation coefficients in Table 2. This inflation of the relationship is caused by the aggregation of the data (across participants) to construct Figure 2 (Robinson, 1950).

Our trivia questions may consist of different categories in terms of the patterns of pre-answer interest, confidence, and post-answer interest ratings. To explore potential classification of trivia questions, we applied a k-means cluster analysis to the 244 trivia question items using the averaged pre-answer interest, confidence, and post-answer ratings as variables (features). Preliminary analysis investigating the sum of squared error scree plot combined with the substantive interpretation of the results indicated a three-cluster solution, and the obtained clusters are colored in Figure 2. To confirm the robustness of the clustering, we conducted a hierarchical cluster analysis and a latent profile analysis and obtained a similar pattern.

The first cluster (violet/light gray) represents the items with relatively low pre- and post-answer interest, and these items are also associated with low confidence. As such, these are the trivia questions that people had no confidence in answering and triggered relatively low pre- and post-answer interest. The second cluster (black) and the third cluster (red green/dark gray) have relatively high pre- and post-answer interest, but, critically, these items are different in their confidence ratings. The second (black) cluster has relatively low confidence, indicating that participants were interested in the answer because they really did not know the answer (low confidence). On the other hand, the third (green/dark gray) cluster has relatively high confidence, indicating that participants became interested in the answer because they failed the question despite the high confidence. These results indicate the potentially different mechanisms that underlie pre- and post-answer interest.

Replication of a Previous Study

Marvin and Shohamy (2016) used a similar trivia question paradigm in which participants indicated their satisfaction with the answer instead of their post-answer interest. They computed an information prediction error (IPE) by deducting pre-answer interest (curiosity) from satisfaction. They found that both pre-answer interest and IPE independently predict memory performance.

For the sake of comparison, we tried to do a similar analysis using our post-answer interest ratings. Specifically, an IPE was calculated by subtracting the raw pre-answer interest ratings from the reported post-answer interest in that trial. For example, a rating of 7 in pre-answer interest and 4 in post-answer interest would result in an IPE of −3. We ran a mixed-effects

Table 3
Variance Explained by Participants, Items, and Participant × Item Interaction and the Estimates of the Reliability Coefficients

Variable	Participant variance	Item variance	Participant × Item interaction	Estimated reliability
Confidence	21.8%	12.3%	65.9%	.984
Pre-answer Interest	52.6%	2.4%	45%	.990
Post-answer Interest	50.3%	4.3%	45.4%	.994
Memory accuracy	10.6%	15.4%	74%	.997

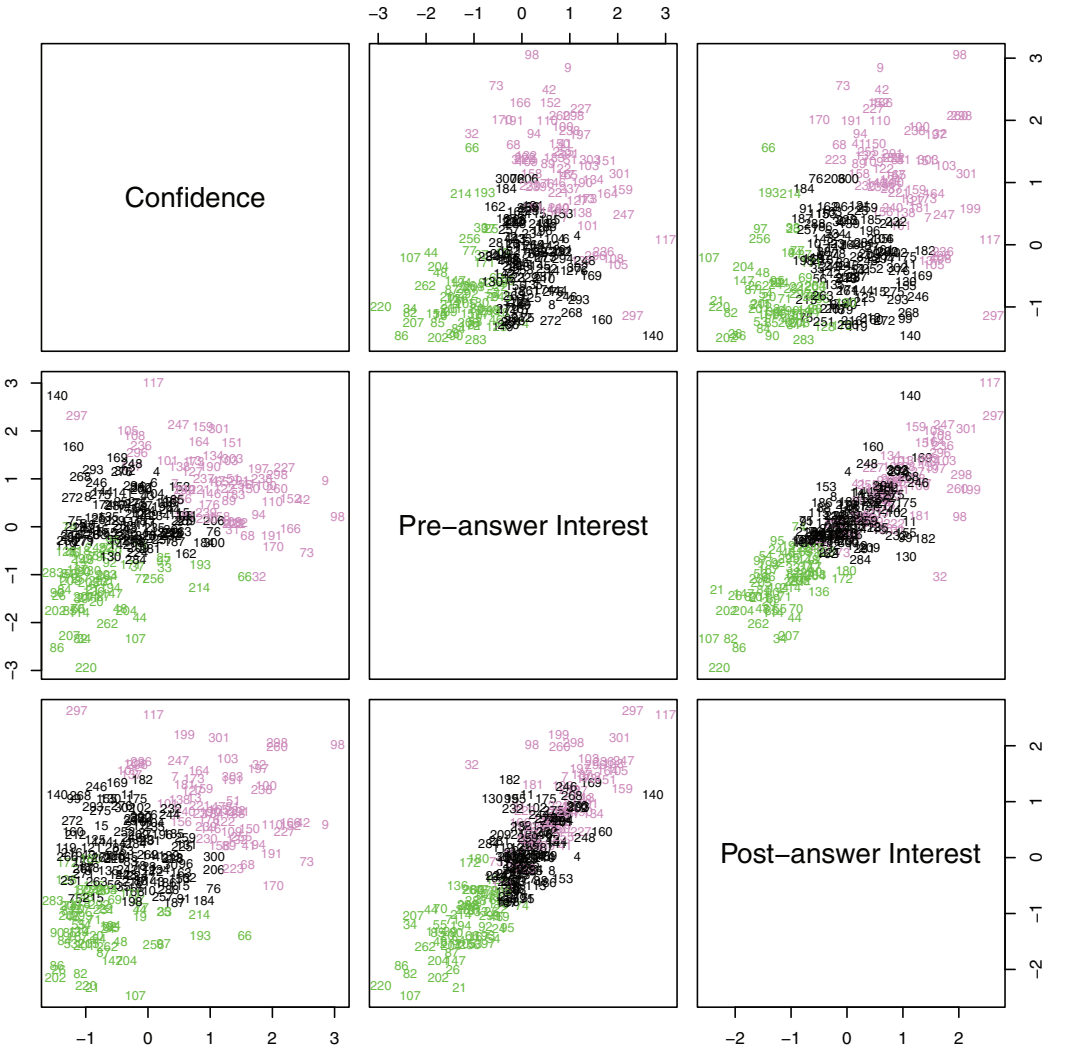

Figure 2. Scatter plots of the 244 trivia question items with pre-answer interest, confidence, and post-answer interest ratings. Numbers in the scatter plots represent the item number in the trivia question database (http://koumurayama.com/resources.php). Results of the cluster analyses are reflected in green (dark gray), black, and violet (light gray) colors. See the online article for the color version of this figure.

logistic regression model to predict memory performance from IPE and pre-answer interest using HLM software (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011). Random participants effect and random effects of pre-answer interest and IPE were specified in the model. Both predictors were centered by participants. Our findings are very similar to Marvin and Shohamy (2016): Memory was significantly predicted by participants' pre-answer interest and the IPE associated with the item ($\beta_0 = -0.597$, $p < .01$; $\beta_{\text{Pre-Interest}} = 0.173$, $p < .01$; $\beta_{\text{IPE}} = 0.150$, $p < .01$).

Multilevel Structural Equation Modeling

To further disentangle the relationship between the epistemic variables (confidence, curiosity, and post-answer interest) and memory accuracy, we conducted a multilevel structural equation model-

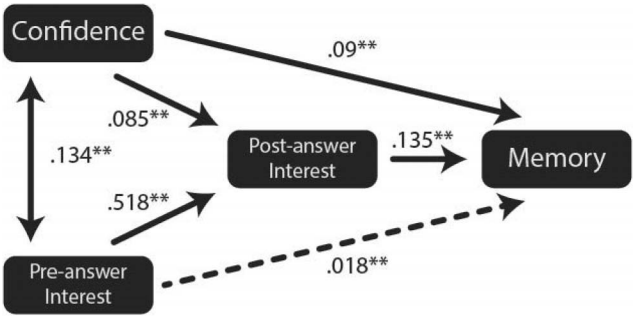

Figure 3. Results of the multilevel structural equation modeling. ** $p < .01$.

ing analysis with trials (items) at level 1 and participants at level 2 with MPlus (Version 7.1.1). More specifically, we modeled the within-person relationship of the variables based on our hypothesized model (see Figure 3), in which confidence and pre-answer interest are distal predictors of memory accuracy and post-answer interest is a proximal predictor, potentially mediating the relationship between the distal predictors and memory accuracy. This is a saturated model, but it still provides the information about the predictive relationship between the variables after partialing out the shared variance of other predictors.

Figure 3 shows the standardized path coefficients. As expected, post-answer interest predicted memory accuracy ($\beta = .135$, $p < .01$), whereas both confidence ($\beta = .085$, $p < .01$) and pre-answer interest ($\beta = .518$, $p < .01$) predicted post-answer interest. In fact, post-answer interest significantly mediated the relationship between confidence and memory accuracy, and the relationship between pre-answer interest and memory accuracy ($ps < .01$). It is important to note that once post-answer interest is accounted for, pre-answer interest remains a significant, but very weak, predictor of memory accuracy ($\beta = .018$, $p < .01$). These results suggest that pre-answer interest trivia questions are more likely to be memorized because interesting questions tend to yield interesting answers, which in turn predicts memory performance. Confidence, on the other hand, was a stronger direct predictor of memory accuracy after controlling for post-answer interest ($\beta = .09$, $p < .01$). These findings suggest that the positive effect of confidence (i.e., hypercorrection effect) can be partly explained by increased post-answer interest (i.e., people become interested in the answers if they unexpectedly receive failure feedback), but there should be other psychological mechanisms involved.

Follow-Up Control Experiment

Trivia questions provide a wide range of cues that limit the search scope of the answer. For example, the question "The title of what animal literally means 'terrible lizard'?" narrows down the answer to the realm of animals; the question "Which poisonous snake secretes an odor like cucumbers?" specifically asks for a snake. Such differences may have influenced the memorability of the answers. In addition, the answers of the trivia questions vary considerably in many aspects, such as word lengths, concreteness, and word frequency; it is possible that these idiosyncratic word characteristics biased our memory results (see also Murayama & Kuhbandner, 2011). For example, it could be that frequent words are considered more interesting as answers. Because frequent words are also more memorable in cued-recall tests (Hulme et al., 1997), the observed interest–memory relationship might be caused by the confounding of word frequency. To investigate whether these factors had any impacts on our results, we concluded a follow-up experiment.

In this experiment, we presented an independent sample of participants ($N = 694$) with word pairs that consisted of the answers of the trivia questions and a cue word taken from the respective question (e.g., Cucumbers—Copperhead Snake). After a delay time of 2 s, participants were asked to rate the relatedness of the two words ("How strongly

do you feel these two terms (left and right side) are related to each other?") on a scale from 1–10, with 1 indicating *very weak relation* and 10 indicating *very strong relation*, followed by ratings as to the complexity of the answer ("How complex do you feel the term on the right side is?") again on a scale from 1–10, with 1 referring to *not complex at all* and 10 to *extremely complex*. The ratings were intended to make participants engaged in processing the word pairs, and, as in the main experiment, the ratings were self-paced. The next word pair followed after the ratings were finished. A week later, we conducted a cued memory test ($N = 461$) in which participants received the cue word and were asked to retrieve the target word (the trivia question answer). In the memory test, participants were also provided with category cues of the target (e.g., Cucumbers – (Snake)).

This follow-up experiment provides us with the memory performance of the answers when they are not asked in the context of trivia questions. Overall memory accuracy was lower than in the main experiment ($M = 0.13$, $SD_{\text{participants}} = 0.09$). We then added the average memory accuracy of the answers as a covariate (predicting pre-answer interest, confidence, post-answer interest, and trivia answer memory accuracy) to the multilevel structural equation model that we ran earlier. The model showed the same pattern of results (for all path coefficients, $ps < .01$), exhibiting little change in standardized path coefficients. These results indicate that our original results are robust even after controlling for the inherent memorability of the answers.

General Discussion

The current study aimed to establish an item pool of trivia questions and to examine the relationship between pre-answer interest, confidence, post-answer interest, and (long-lasting) memory performance. With several screening steps (see Methods), we obtained a final set of 244 trivia questions with different levels of pre- and post-answer interest. The analysis of this large pool of items showed that both pre-answer interest and post-answer interest are positive predictors of memory performance but post-answer interest is a more proximal predictor, mediating the relationship between pre- and post-answer interest. High-confidence errors led to increased memory performance, and this was partly explained by increased interest in the answers. These results have provided a fine-grained picture of how epistemic emotions (pre- and post-answer interests, and confidence) jointly influence memory performance.

Previous studies have demonstrated the relationship between interest and memory performance, but the current study illustrated the importance of differentiating between a pre- and postknowledge state. For example, Kang et al. (2009) showed that initial interest triggered by trivia questions is a strong predictor of later memory performance, but they did not examine or control for post-answer interest; our results suggest that it may be post-answer interest, rather than interest prior to the answer, which directly predicted memory performance. Note, however, that we did still find a significant direct positive relationship between pre-answer interest and memory. This is consistent with Gruber et al.'s (2014) findings. Within the trivia question paradigm, they presented participants with task-unrelated pictures of faces between the presentation of the question and the answer. They showed that the strength of interest in the answer had an impact on the incidental memory for the unrelated faces. For both this and our study, however, effect size is much smaller (e.g., $\beta = .02$ in our study) than the research that did not control for post-answer interest (e.g., Kang et al., 2009), indicating the importance of considering post-answer interest when examining interest-memory relationships. In addition, a body of studies has shown that high-confidence errors lead to increased memory—the hypercorrection effect (e.g., Butler et al., 2011; Butterfield & Metcalfe, 2001; Metcalfe & Miele, 2014). Most studies have used general knowledge questions to investigate this effect, and it has been argued that the hypercorrection effect is caused by prior knowledge of the question matter and enhanced attention to the answers (Sitzman, Rhodes, Tauber, & Liceralde, 2015). On the other hand, our study suggests that increased post-answer interest can account for some (but not all) of the hypercorrection effect, providing another potential mechanism underlying the phenomenon.

Conceptual Issues

In the present study, we made the distinction between pre- and post-answer interest and showed that these two types of interest have unique effects on memory performance, validating the distinction between these motivational states. These findings are also consistent with previous theoretical perspectives. For example, Loewenstein (1994) suggested that when individuals are made aware of a lack of knowledge, an aversive feeling drives them to fill the gap (i.e., pre-answer interest), whereas the acquisition of knowledge is followed by a positive emotion (i.e., post-answer interest). However, there has been a profound disagreement on what we should call these distinct stages of motivational states. Several researchers argued that these two types of interest map onto the distinction between curiosity and interest (Grossnickle, 2016; McGillivray et al., 2015), but many other studies use these two terminologies rather interchangeably, making little distinction between them. Boscolo, Ariasi, Del Favero, and Ballarin (2011), for example, integrated measurement of curiosity as a subcomponent for interest and Silvia, Henson, and Templin (2009) included both trait curiosity and situational interest ratings within their study to investigate appraisal structures of art without discussing conceptual differences. Some papers also suggest that interest is often produced by an uncertainty-creating event, adding further breadth to the definition of curiosity and interest (Oudeyer & Kaplan, 2008; Silvia, 2005). Renninger and Hidi (2016) argued that Litman's theory of curiosity can be seen as a feeling of deprivation of knowledge that is accompanied by negative affect (see Litman & Jimerson, 2004), whereas interest is seen as a positive experience that can be abandoned at any time without evoking negative feelings. The current investigation used rather arbitrary terms (pre-answer and post-answer interests) to avoid the complications associated with the distinction between curiosity and interest and simply empirically indicated that pre-answer and post-answer interest may represent distinct psychological processes (in relation to learning), but future research is needed to investigate a potential distinction between curiosity and interest in more detail (see Grossnickle, 2016).

The conceptual issues go beyond the constructs of curiosity and interest. Baranes, Oudeyer, and Gottlieb (2014) showed that pre-answer curiosity ratings were highly correlated with self-reported surprise about the answer. Given the high correlation we found between pre-answer and post-answer interests, it is possible that the surprise people felt when they read the answer is related to post-answer interest. Indeed, Berlyne (1966) suggested that surprise is one of the (but not the only) factors that lead to feelings of interest/curiosity. Another factor that may be relevant is post-answer satisfaction. As indicated earlier, Marvin and Shohamy (2016) asked participants to indicate how satisfied they were with a received trivia question answer, and one could argue that this satisfaction measure is conceptually similar with the post-answer interest assessed in our study. According to several theoretical literature (Berlyne, 1960; Hidi & Renninger, 2006; Ryan & Deci, 2000; Silvia, 2010) we view surprised and satisfaction as one of the determining factors of post-answer interest, but future research is necessary to causally disentangle related, yet separate, constructs.

Interest, Retrieval Attempt, and Memory

All studies that examined pre-answer interest–memory relations (including the current study) using trivia questions have first asked participants to answer new trivia questions in an initial test phase. This initial test phase is necessary to induce (and assess) participants' pre-answer interest, but it is important to note the initial test phase also inevitably activates another psychological process: retrieval attempt. A number of studies in memory literature have demonstrated that retrieval attempt is one of the critical factors that facilitate memory performance. For example, Kornell, Hays, and Bjork (2009) presented general knowledge questions and their corresponding answers to participants and examined their memory for the answers in a later memory test. It is important to note that in half of the trials, participants were asked to guess the answer before seeing the correct answer. The results showed that the act of making a guess enhanced learning in comparison to simply studying question–answer pairs without attempting to produce the correct answer, indicating the role of retrieval attempts in facilitating learning (see also Potts & Shanks, 2014). The importance of retrieval attempts or effortful retrieval in learning has also been underscored in the

literature of the testing effect (Roediger, Putnam, & Smith, 2011, for a review). This line of work has suggested that testing with feedback enhances learning through active and effortful retrieval of learned materials.

Our results suggest that the pre-answer interest felt during the retrieval attempt only has a minor impact on later memory performance for the answer. Nonetheless, failure to retrieve a correct answer after making an attempt is likely to make people aware of a knowledge gap (Loewenstein, 1994), triggering pre-answer interest and thus impacting post-answer interest. In the literature on the testing effect, materials are often experimentally well controlled (e.g., word-pairs) and little engaging; during a test, though, participants' interest in whether or not a prior retrieval attempt was correct is likely inevitable. We in no way intend to argue that the findings of these studies can be entirely explained by epistemic emotions. However, we think it is worthwhile to consider the role of epistemic emotions in retrieval attempt and memory, as these emotions can directly enhance learning consolidation without cognitive elaboration processes (Gruber et al., 2014; see also Murayama & Kitagami, 2014).

There are indeed studies that suggested the role of pre-answer interest in the facilitative effects of retrieval attempts on learning performance. Berlyne (1966) may be the only study that directly examined the role of pre-answer interest in retrieval attempts and memory performance. He presented high school students with famous quotes; participants in one condition were asked to guess the correct authors of the quotes, each of which was followed by the presentation of a fake correct author. Participants then took an immediate memory test, after which they were asked to indicate on a different sheet which author they would like to know more about. The results showed that guessing the correct author increased participants' pre-answer interest ($d = .22$), although the difference was not statistically significant, and pre-answer interest was indeed related to improved memory performance. For another example, Agarwal, Karpicke, Kang, Roediger, and McDermott (2008) found that students who took an initial short-answer test after studying text passages performed better in a later memory test than when they only restudied the passages. It is important to note that they further examined how feedback influenced long-term memory retention. They found that feedback enhanced memory retention, but this effect was stronger if feedback was given after a short delay than during the completion of an initial test. This is reminiscent of Mullaney et al.'s (2014) previously discussed findings on interest and memory, indicating the potential role of pre-answer interest in their study. Another question that should be answered is whether the role of preknowledge and postknowledge is similar to our findings when no retrieval attempt is made. This cannot be answered within the trivia question paradigm.

Our Database

Establishing standardized materials is important. It not only helps move research forward more quickly by avoiding redundant work, but also improves the interpretation of research by increasing the comparability across studies (Sochat et al., 2016). We aimed to achieve that goal in the research of interest by providing the first publicly available database of more than 200 trivia questions. The database includes the average ratings of pre-answer interest, confidence, post-answer interest, and memory performance (and memory performance of the answers without presenting the questions) from almost 1,500 participants, allowing researchers to calibrate the extent to which these trivia questions trigger such epistemic emotions.

We hope that researchers find the database useful in future research, but there are some limitations that should be noted. First, we intended to include items with low pre- or post-answer interest, but the results showed that participants found most of the items interesting, even if they are plain factual questions such as "Which chemical element belongs in the Halogen Family with fluorine, chlorine, bromine and astatine?" (Answer: "Iodine"; $M_{\text{Pre-Interest}} = 6.33$; and $M_{\text{Post-Interest}} = 6.30$). This suggests that engaging in a quiz-like task with moderately difficult questions is inherently enjoyable, and it is difficult to produce pure boredom in participants. Thus, although our selected trivia questions are variable enough to relatively distinguish interesting and less interesting items, it should not be used to create a mental state of very low interest or pure boredom. Second, as indicated by the variance decomposition analysis, only a limited amount of variance in ratings can be explained by the differences in mean item preferences (i.e., item effect), indicating that there are substantial individual differences in how interest-

ing people find trivia questions in general (i.e., participant effect; this likely reflects both general response bias and trait interest; see Kashdan & Steger, 2007) and which trivia questions they find interesting (i.e., item by participant interaction; this may represent individual differences in personal interest and knowledge about the topic of a question). Thus, although the mean rating scores obtained from the current large sample are still reliable and useful for selecting generally interesting and less interesting trivia questions, it is also important for researchers to assess pre- and post-answer interest on an individual basis whenever possible.[2]

Future Directions

Research using trivia questions cannot avoid one inherent, potential confounding factor influencing memory: prior knowledge. Even if a participant cannot correctly answer a trivia question in the initial test phase, it is possible that the participant partially knew the answer, resulting in better memory for this trivia question. It is important to note that as the information gap theory (Loewenstein, 1994) indicates, previous knowledge can also change the amount of curiosity triggered by the trivia question: The theory posits that curiosity increases with knowledge in its domain because, the more one already knows about a certain subject, the less there is to know and the easier it is to close the knowledge gap. This observation indicates that the relationship between interest and memory performance could, in part, be explained by previous knowledge. Indeed, Berlyne (1954a) showed that information was better remembered when participants were more familiar with an animal and that people who received more information about an exotic animal were more likely to indicate their curiosity about it. Although the current study tried to control for the effects of previous knowledge by limiting the trivia questions that had a low correct answer rate in the initial test phase and by controlling for memory performance that is detached from the context of trivia questions (follow-up study), future research that rigorously controls for previous knowledge in testing the effects of interest on memory performance is needed.

Although the current research has focused only on trivia questions as a way to induce pre-answer interest in experimental settings, we do not claim that this is the best paradigm to examine interest–memory relationships. We need to examine the generalizability of the findings using different materials and manipulation methods. Obviously, trivia questions cover only part of our experiences of interest. Trivia questions induce interest for trivia facts, which are irrelevant to people's daily lives and should thus be of little personal value. This is a nice feature in that trivia questions can control for many extraneous factors related to interest (e.g., practical value of knowledge) and thus allows researchers to examine intrinsic, epistemic value of interest. But interest is not only about trivia facts. As discussed earlier, though, Hidi and Renninger's (2006) four-phase model of interest development draws a distinction between situational and individual interest: Situational interest is a momentary interest that arises in responses to characteristics of a situation (e.g., the reading of a newspaper headline), whereas individual interest is a relatively stable motivational-evaluative orientation that emerges when people internalize the value of the topic. According to this model, research using trivia questions is related only to situational interest, and individual interest may have different implications for people's learning. Although challenging, future research needs to develop new experimental materials that can reveal the dynamics between situational and individualized aspects of pre- and post-answer interest.

[2] Another limitation of the database is that our norming sample may not be comparable to the typical sample in psychology research—undergraduate students. For those who are interested in detailed analysis on the demographic differences, we are happy to share the raw data upon request.

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Appendix A

Final Set of Trivia Questions

Item no.	Question	Answer
4	What is the best-selling music album of all time?	*Thriller*
5	Which country has a national anthem that consists of only 32 syllables?	Japan
6	Which planet in the solar system is the only one that rotates clockwise?	Venus
7	Which product, after oil, is the most frequently traded product around the world?	Coffee
8	Which country has the world's only non-quadrilateral national flag?	Nepal
9	What is the country with the highest population density?	Monaco
10	Which fish can produce more eggs than any other known vertebrate?	Sunfish
11	What disability did Thomas Edison suffer from?	Deafness
13	What breed of dog is the only animal whose evidence is admissible in some USA courts?	Bloodhound
14	What Beatles song remained the longest on the music charts?	"Hey Jude"
15	What is the only lizard that has a voice?	Gecko
17	Which chemical element belongs in the Halogen Family with fluorine, chlorine, bromine and astatine?	Iodine
18	What island country lies off the south-east coast of India?	Sri Lanka
19	What is the longest river in Asia?	Yangtze
20	What is the monetary unit in Korea?	Won
21	What is the name of the artist who painted the "Tahitian Women on the Beach"?	Paul Gauguin
22	What is Spain's national flower?	Carnation
23	In which country is Angel Falls, the tallest waterfall, located?	Venezuela
24	What is the largest temple in Egypt?	Karnak
25	In which country is the temple of "Angkor Wat" located?	Cambodia
26	What is the abbreviated name of the political and economic integration in Southeast Asia?	ASEAN
27	What is the largest freshwater lake in the world by surface area?	Lake Superior
30	Which popular Greek philosopher is said to have tutored Alexander the Great?	Aristotle
31	What color are cranberries before they turn red?	White
32	Which company is the largest manufacturer of tires?	Lego
33	In which country is the city Marrakesh located?	Morocco
34	Which Australian state was formerly known as Van Diemen's Land?	Tasmania
35	What insulates the ice cream to prevent it from melting in the hot dish "Baked Alaska"?	Meringue
37	What body of water does the Danube River flow into?	Black Sea
39	Which Disney cartoon character's love interest is named Faline?	Bambi
40	What was the original Dutch name of New York City?	New Amsterdam
41	What purpose did the Coliseum serve when first built?	Amphitheatre
42	What is the largest bear on earth?	Polar Bear
43	What is added to white sugar to make brown sugar?	Molasses
44	What fiber-producing plant is attacked by the boll weevil?	Cotton
46	What is the name of Beethoven's only opera?	*Fidelio*
47	What is the largest known animal to have ever existed?	Blue Whale
48	In which city would you find the Hermitage art gallery?	Saint Petersburg
51	Which country has the longest coastline?	Canada
53	What is the last name of the cosmonaut who first orbited around the Earth?	Gagarin

(*Appendix continues*)

Appendix A (*continued*)

Item no.	Question	Answer
54	What is the name of the smallest state surrounded by Italy other than Vatican City?	San Marino
55	What Spanish city is the capital of Catalonia?	Barcelona
56	What does an ichthyologist study?	Fish
66	What is the name of the company that produces "Baby Ruth" candy bars?	Nestle
68	In which European city is the Parthenon located?	Athens
69	What is the last name of the man who first studied genetic inheritance in plants?	Mendel
70	What was the name of the zeppelin that exploded in Lakehurst, NJ, in 1937?	Hindenburg
71	What is the name of the palace built in France by King Louis XIV?	Versailles
72	In what ancient city were the "Hanging Gardens" located?	Babylon
73	What is the capital city of Australia?	Canberra
74	What is the name of the ship on which Charles Darwin made his scientific voyage?	HMS Beagle
75	What is the name of the fountain in Rome into which coins are thrown in for good luck?	Trevi
76	In which city is Michelangelo's statue of David located?	Florence
77	Of which country is Nairobi the capital?	Kenya
78	What is the last name of the first person to complete a solo flight across the Atlantic Ocean?	Lindbergh
79	What is the name of the Roman emperor who played the fiddle while Rome burned?	Nero
80	What is the last name of the scientist who discovered radium?	Curie
81	What was the last piece of music Mozart composed?	Requiem
82	What is the last name of the author of the James Bond novels?	Fleming
83	What was the name of the Apollo lunar module that landed the first man on the moon?	Eagle
84	What was the name of the goldfish in the story of Pinocchio?	Cleo
85	What is the name of the submarine in Jules Verne's*20,000 Leagues Beneath the Sea*?	Nautilus
86	What is the last name of the European author who wrote *The Trial*?	Kafka
87	What is the last name of the poet who originally wrote "Don Juan"?	Byron
88	Who was the first ruler of the Holy Roman Empire?	Charlemagne
89	What is the name of the brightest star in the sky, excluding the sun?	Sirius
90	What is the name of Germany's largest battleship that was sunk in World War II?	Bismarck
91	What is the name of the mountain range that separates Asia from Europe?	Ural
92	What is the name of the instrument used to measure wind speed?	Anemometer
94	Which planet in our solar system was the last to be discovered?	Neptune
95	Which sport uses the terms "stones" and "brooms"?	Curling
96	What is the name of the unit of measure that refers to a six-foot depth of water?	Fathom
97	Who is known as "the father of geometry"?	Euclid
98	What is the name of the largest desert on earth?	Antarctica
99	What flavor is the extract of fermented and dried pods of several species of orchids?	Vanilla
100	Which is the only continent without a desert?	Europe
101	Where is the largest Volcano on Earth located?	Hawaii
102	What animal's milk does not curdle?	Camel
103	What wild animal in Africa has killed the most people?	Hippo

(*Appendix continues*)

Appendix A (*continued*)

Item no.	Question	Answer
104	What is the only domestic animal not mentioned in the Bible?	Cat
105	What spice is extremely poisonous if injected intravenously?	Nutmeg
107	Who was the first winner of the FIFA World Cup?	Uruguay
108	What animal can eat only when its head is upside down?	Flamingo
109	Which bird is the international symbol of happiness?	Bluebird
110	Which is the largest joint in the body?	Knee
111	What was once called brimstone?	Sulfur
114	Ankara is the capital city of which country?	Turkey
115	In which country are the ruins of the City of Carthage situated?	Tunisia
117	What is the only food that never spoils?	Honey
118	In food, E330 is better known by what name?	Citric acid
119	What did Joseph Priestley discover in 1774?	Oxygen
121	Who is the Greek God of music?	Apollo
122	What is the name of the largest island in the world?	Greenland
123	Which fruit was previously known as a Chinese gooseberry?	Kiwi
125	What is the correct term for a female elephant?	Cow
127	What color is octopus' blood?	Blue
128	What is a baby oyster called?	Spat
130	Where in the body are male lobsters' bladders located?	Head
131	In which city was the Titanic built?	Belfast
132	What is the most common blood type in humans?	O positive
134	What was the first internal human organ to be successfully transplanted?	Kidney
135	Which poisonous snake secretes an odor like cucumbers?	Copperhead Snake
136	What does the Scoville scale of food measure?	Spicy Heat
137	Which land mammal has the highest blood pressure?	Giraffe
138	What was the first nation to give women the right to vote?	New Zealand
139	What is the name of the biggest constellation in the sky?	Hydra
140	What is the longest common English noun without any vowels?	Rhythm
141	What musical note do most American car horns beep in?	F
142	Who was the first Christian emperor of Rome?	Constantine
143	The Gold Coast is now known as what country?	Ghana
144	What is the only country in the world that has a bible on its flag?	Dominican Republic
145	What trade was Greek philosopher Socrates trained for?	Stonecutting
146	What reptile, according to ancient legend, was able to live in fire?	Salamander
147	What unit of measurement is used for fuel wood?	Cord
148	What did the D in DC comics originally stand for?	Detective
150	What is the most abundant gas in the atmosphere?	Nitrogen
151	Which city is the most expensive city in the world to live in?	London
152	Which country is the world's biggest producer of olive oil?	Spain
153	Which animal has the shortest lifespan?	Mayfly
155	What is the only fish that can blink with both eyes?	Shark
156	What is the fastest creature on two legs?	Ostrich
157	What is the more common name of the plant Hedera?	Ivy
158	What is the last letter of the Greek alphabet?	Omega
159	What is the only internal human organ capable of natural regeneration of lost tissue?	Liver
160	Which city is the only one in the world to be situated in two continents?	Istanbul
161	Disney's *Lion King* movie/musical is generally said to be based on what Shakespeare play?	Hamlet
162	Where in the world is the world's largest building (the Burj Khalifa) located?	Dubai

(*Appendix continues*)

Appendix A (*continued*)

Item no.	Question	Answer
163	The hot condiment wasabi is generally from what part of the plant?	Root
164	What language has the largest vocabulary?	English
165	What color flag was historically first displayed to indicate sickness aboard a ship?	Yellow
166	Which famous religious leader is depicted in the largest statue in the world?	Buddha
167	Until 2008, what country was the only one to display a map of their country on their flag?	Cyprus
168	What is an ice hockey puck made from?	Rubber
169	Which animal tastes with its feet?	Butterfly
170	What color is vermilion a shade of?	Red
171	Broccoli belongs to what family of plants?	Cabbage
172	What is the National Bird of India?	Peacock
173	Where on the human body is the skin the thinnest?	Eye
174	What was the first country to leave the United Nations?	Indonesia
175	Which animal sleeps with one eye open?	Dolphin
176	73% of what country is covered by forest?	Finland
177	Scooby Doo is based on what breed of dog?	Great Dane
178	What is measured with an ombrometer?	Rainfall
179	The linden tree is more commonly known as what?	Lime Tree
180	Viticulture is the growing of what plant?	Grapes
181	What food did the Aztecs reckon was the food of the Gods?	Chocolate
182	What bird has the most feathers per square inch?	Penguin
183	What country is coffee originally from?	Ethiopia
184	In which ocean are the Canary Islands located?	Atlantic
185	Which city was the first in the world to have a public bus service?	Paris
186	What is the world's fifth largest religion?	Sikhism
187	At the end of what period did dinosaurs become extinct on earth?	Cretaceous
190	What was the first planet to be discovered by telescope?	Uranus
191	What nationality was Picasso?	Spanish
193	What is the highest range of the male singing voice?	Countertenor
194	What type of acid is used in car batteries?	Sulfuric
196	What is the color of mourning in Turkey?	Violet
197	Which islands wildlife is 90% unique?	Madagascar
198	Where in the body would you find the pisiform bone?	Wrist
199	What color are Amazon river dolphins?	Pink
200	What dog breed has the best eyesight?	Greyhound
201	Barajas is the main airport in what city?	Madrid
202	What Polish political movement got the support of Pope John Paul II in the 1980's	Solidarity
203	What was the surname of the leader who said 'Never before have we had so little time in which to do so much'?	Roosevelt
204	What was the surname of the first democratically elected president of Russia?	Yeltsin
205	The forint is the monetary unit of what central European country?	Hungary
206	In what century was Leonardo da Vinci born?	15th
207	What is the name of the composer who wrote Don Giovanni?	Mozart
208	Along with chitin, what strengthens the exoskeleton of bugs?	Calcium
209	What do birds rely on to swallow?	Gravity
210	What animal is the 'Turdus migratorius' better known as?	American Robin
211	What radioactive element is extracted from carnotite and pitchblende?	Uranium
212	Who was the first physician to record case histories of patients?	Hippocrates
213	Copper and what else are the two main constituents of bronze?	Tin

(*Appendix continues*)

Appendix A (*continued*)

Item no.	Question	Answer
214	What body part is low-density lipoprotein most likely to clog?	Arteries
215	What are you shopping for if you're sized up by a Brannock Device?	Shoes
216	What chemical compound comes from the Greek word for 'primary'?	Protein
217	Hydrogen and what are thought to be the primary elements of which Jupiter is composed?	Helium
218	What was the name of the first probe to send back pictures from Mars?	Viking
220	Yapping Deng was a world champion in which sport?	Table Tennis
221	Coconut and what other fruit were Hawaiian women once forbidden by law to eat?	Banana
222	From what vegetable were jack-o-lanterns originally carved?	Turnips
223	What was the first war in which one jet plane shot down another?	Korean War
224	What nation started giving gas masks to its citizens before the Persian Gulf War?	Israel
225	What was the surname of the first president to appear on a U.S coin?	Lincoln
227	What food is the leading source of salmonella poisoning?	Chicken
228	What is the second largest island in Europe?	Iceland
229	What was the poison used at Socrates' execution?	Hemlock
230	Who was first to publish the theory that the Earth revolves around the sun?	Copernicus
231	What studio did the Beatles use to record 191 songs?	Abbey Road
232	What elemental event rejuvenates a prairie, causing more plants to grow taller, flower and produce seed?	Fire
234	What is the longest venomous snake?	King Cobra
235	What common insect depends the most on sight, rather than sound, to locate mates?	Firefly
236	What taste are cats unable to detect?	Sweet
237	Christopher Columbus introduced what animal to North America?	Pig
238	What sea creature can have an eye measuring 16 inches, the largest in the animal kingdom?	Squid
239	What was the first bird domesticated by man?	Goose
240	The title of what animal literally means 'Terrible lizard'?	Dinosaur
242	In what century did mathematicians first use plus and minus signs?	16th
243	What unit of measure was once defined as the length of 3 grains of barley laid end to end?	Inch
244	What direction did cartographers usually place at the top of maps when they believed the Earth was flat?	East
245	The element Manganese gives what crystal its famous violet color?	Amethyst
246	What were thermometers filled with in the 17th century, before mercury?	Alcohol
247	What is the only living part of the human body that has no blood supply?	Cornea
248	What illegal hallucinogen naturally occurs in many plants and mammals including humans?	DMT
251	What was the name of the first chimpanzee sent into space by America?	Ham
252	Which planet has a hexagon shaped cloud formation on its north pole?	Saturn
253	Neptune gets its blue color from what gas?	Methane
255	What is the only country to have won at least one gold in every Olympic Games?	Great Britain
256	What kind of fruit basket was used for the first game of basketball?	Peach
257	What is the proper name of a badminton bird?	Shuttlecock
259	South America first saw the cultivation of what vegetable in 200 A.D.?	Potato

(*Appendix continues*)

Appendix A (*continued*)

Item no.	Question	Answer
260	Which animal's milk is used to make authentic Italian mozzarella cheese?	Water Buffalo
261	What added ingredient keeps confectioners' sugar from clumping?	Cornstarch
262	What flavor is the liqueur Cointreau?	Orange
263	What type of fruit would you pick from a Mirabelle tree?	Plum
264	Calvados is brandy made from which fruit?	Apple
266	Which drink gets its name from a town on the Red Sea coast of Yemen?	Mocha
267	What food product did Hippolyte Mege-Mouries invent by treating oils with hydrogen?	Margarine
268	On what vegetable did an ancient Egyptian place his right hand when taking an oath?	Onion
269	What is the only country with a national dog?	Netherlands
271	What is the side of a hammer called?	Cheek
272	What is the term for rainforests higher than 3000 feet above sea level?	Cloud forests
275	What is the only breed of dog that can get gout?	Dalmatian
276	What is the world's smallest mammal?	Bumblebee Bat
277	What is the only cat in the world that cannot retract its claws completely?	Cheetah
281	What was the world's first National Park?	Yellowstone
282	What is the only mammal native to Iceland?	Arctic Fox
283	What type of spider wasp eats tarantulas?	Tarantula hawk
284	What is a group of goats called?	Trip
287	What is the only rock that floats in water?	Pumice
288	What gland makes hormones that trigger puberty?	Pituitary
291	What part of a cola tree is used to flavor beverages?	Nuts
292	Which member of the ginger family is used to color curries?	Turmeric
293	Ingesting large amounts of what type of unripe berry can cause moderate hallucinations?	Mulberry
294	What type of animal was the Snickers candy bar named after?	Horse
296	What type of bean must be cooked thoroughly for all the cyanide to be extracted?	Lima bean
297	The liquid found in what fruit can be used as a substitute for blood plasma in emergencies?	Coconut
298	What American State has the highest percentage of people who walk to work?	Alaska
299	What is the surname of the former Soviet Russian leader who endorsed Louis Vuitton and Pizza Hut?	Gorbachev
300	What animal's antlers are the fastest growing animal cells in nature?	Moose
301	What water-dwelling creature can make a sound loud enough to break glass?	Pistol Shrimp
302	What is the only animal that can turn its stomach inside out?	Starfish
303	What is the fastest healing body part on a human?	Tongue

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