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Using the Internet to access information inflates future use of the Internet to access other information

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ABSTRACT

The ways in which people learn, remember, and solve problems have all been impacted by the Internet. The present research explored how people become primed to use the Internet as a form of cognitive offloading. In three experiments, we show that using the Internet to retrieve information alters a person's propensity to use the Internet to retrieve other information. Specifically, participants who used Google to answer an initial set of difficult trivia questions were more likely to decide to use Google when answering a new set of relatively easy trivia questions than were participants who answered the initial questions from memory. These results suggest that relying on the Internet to access information makes one more likely to rely on the Internet to access other information.

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Memory; cognitive offloading; technology; metacognition; retrieval

Participants are often asked to turn off their cell phones before beginning a memory experiment. There are good reasons for this policy, but one might argue that what participants are being asked to do is effectively turn off part of their minds (Clark & Chalmers, 1998). Functions that used to be accomplished solely in our heads are now accomplished with the help of technology. We no longer need to remember phone numbers, directions, birthdays, or medical information; the value of accumulating a vast knowledge base to ensure access to some specific bit of knowledge has never been less. The information we desire is often just a Google Search away, a development which has begun to profoundly alter the ways in which we think and remember. Indeed, to study memory exclusively in the absence of the Internet would provide a necessarily limited view of how we store, access, and use knowledge in the modern world.

The Internet functions as a transactive memory partner (Sparrow, Liu, & Wegner, 2011; Ward, 2013a; Wegner, 1987). Rather than retain information internally, we remember where information can be accessed. Research by Sparrow and colleagues, as well as others (e.g., Barr, Pennycook, Stolz, & Fugelsang, 2015; Ferguson, McLean, & Risko, 2015; Henkel, 2014; Storm & Stone, 2015), has shown that we use digital technology as a form of cognitive offloading. If information is going to be available on a computer or the Internet, then there is less need to commit it to memory. Sparrow et al., for example, showed that difficult trivia questions increase the accessibility of terms related to the Internet (e.g., Google, Yahoo), suggesting that people are primed to think about the Internet when they encounter questions to which they do not know the answers. Searching the Internet has even been shown to lead to illusions of internal knowledge (Fisher, Goddu, & Keil, 2015; Ward, 2013b). Having unfettered access to so much information makes it difficult to determine what is available in the head versus what is available online.

Research has only begun to investigate the ways in which memory interacts with the Internet. In the current study, we explore the hypothesis that a person's likelihood of relying on the Internet as a transactive memory partner is affected by their recent experiences with the Internet. Specifically, does using the Internet to access information influence a person's propensity to use the Internet to access other information? Research has shown that people can become increasingly reliant on particular methods of accessing information and solving problems (Smith, 2008). They attempt to solve problems in the same ways they did before, for example, often despite having access to much simpler and more effective means of achieving solutions (Luchins, 1942). Similar dynamics may take place in the context of transactive memory. Namely, using a particular information source, such as the Internet, may make people more likely to rely on that information source for accessing other information in the future than they would have been otherwise.

A paradigm was developed to explore this possibility. First, participants were given a set of difficult trivia questions. Some participants were asked to answer the questions from memory, whereas others were asked to

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answer the questions with the help of the Internet. All participants were then asked relatively easy trivia questions and given the option of using the Internet to find the answers. Specifically, participants were asked to answer each question by either searching their own memory or by conducting a Google Search. We predicted that participants who were instructed to use the Internet to answer the first set of questions would rely more on the Internet while answering the second set of questions than would participants who were instructed to answer the first set of questions from memory. Such a result would suggest that a person's tendency to rely on the Internet to access information can be exacerbated by the recent use of the Internet to access other information.

Experiment 1a

Method

Participants: Sixty undergraduates from the University of California, Santa Cruz (UCSC), participated for course credit (mean age = 19.6). Participants were randomly assigned to one of three between-subject conditions (Internet, Memory, and Baseline).

Materials: Sixteen trivia questions on the topics of history, sports, and pop culture were selected after piloting from a trivia book (Appendix). Eight questions were chosen to be relatively difficult (answerable by some but not most participants without the help of the Internet; e.g., "What did King John sign in 1215?"), whereas the other eight were chosen to be relatively easy (answerable by most participants without the help of the Internet; "What is the center of a hurricane called?").[1]

Procedure: The experiment consisted of two phases. In the first phase, participants in the Internet and Memory conditions were asked the eight difficult trivia questions. Participants in the Baseline condition were not asked any trivia questions. The questions were presented one at a time out loud by the experimenter, with participants instructed to respond as quickly and as accurately as possible. Participants in the Internet condition were told to use Google Search to answer each question. They were told to do this even if they thought they knew the answer. Participants in the Memory condition were given the same instructions except Google was not mentioned and they were told to answer the questions from memory. No feedback was given in either condition.

The second phase followed immediately after the first, and was identical for participants in all three conditions. The experimenter read the eight easy trivia questions out loud and participants were instructed to answer each question as quickly and as accurately as possible. Unlike in the first phase, participants were now given the *option* of using Google to find the answer to each question. They were told that although they were allowed to use Google, they were not required to use Google. In other words, it was up to them to determine whether they would answer a given question from memory or with the help of the Internet. The measure of interest was the proportion of questions in which participants chose to use Google. In this experiment, as well as in all subsequent experiments, browsing history was cleared between participants to prevent prior searches from biasing future searches.

Results

The proportion of questions on the second set for which participants used Google Search was analysed using a one-way ANOVA (Internet vs. Memory vs. Baseline). A significant main effect was observed, $F(2, 57) = 6.07$, MSE = .244, $p = .004$. Participants in the Internet condition ($M = 83\%$, SE = 3%) used Google significantly more often than did participants in the Memory condition ($M = 63\%$, SE = 5%), $t(38) = 3.23$, $p = .003$, $d = 1.02$, $CI_{95\%} = [.07, .33]$, and Baseline condition ($M = 65\%$, SE = 5%), $t(38) = 3.17$, $p = .003$, $d = 1.00$, $CI_{95\%} = [.07, .30]$. A significant difference was not observed between the Baseline and Memory conditions, $t(38) = .27$, $p = .79$, $d = .08$, $CI_{95\%} = [-.16, .12]$. These results show that using the Internet to answer an initial set of questions made participants more likely to use the Internet to answer a new set of questions than they would have been had they (1) not been asked to answer any initial questions or (2) been asked to answer initial questions from memory.

Experiment 1b

We next sought to replicate Experiment 1a while making the option of using the Internet less appealing. In Experiment 1a, participants were seated immediately in front of a computer, making it relatively easy and inconsequential to consult Google when answering a question. In many settings, however, there is a cost or inconvenience to using the Internet. Using a computer or phone takes time, for example, and may not be contextually appropriate. In Experiment 1b, participants answered the first set of questions as they did in the Internet and Memory conditions of Experiment 1a, either with or without the help of the Internet, which was accessible via the computer in front of them. Before beginning the second set of questions, however, participants were seated on a sofa and told that if they wanted to conduct a Google Search they would have to physically stand up and walk over to the computer desk located on the other side of the room. A new manipulation served to make using the Internet even more inconvenient. Whereas half of the participants were allowed to use the computer to answer the second set of questions, the other half were required to use a first-generation iPod touch. Although functionally similar to a computer, the iPod touch was slower and less user-friendly, making it less appealing to use. We predicted that although participants might be less likely to use Google overall in this experiment compared to the previous experiment (and in the iPod condition relative to

the Computer condition), they would still nonetheless become more reliant on it in the Internet condition than in the Memory condition.

Method

Participants: Eighty UCSC undergraduates participated for course credit (mean age = 20.2), with one participant needing to be replaced due to experimenter error. Participants were randomly assigned to one of four between-subject conditions (Internet-Computer, Internet-iPod, Memory-Computer, and Memory-iPod).

Materials and procedure: The first phase of the experiment was identical to that of Experiment 1a. Participants were seated in front of a computer and asked to answer eight difficult questions without feedback either from memory (Memory condition) or by using Google (Internet condition). Before beginning the second phase of the experiment, participants were seated on a sofa located approximately two metres from the computer. As in Experiment 1a, all participants were then given the option of using Google to answer the eight easy questions. Participants in the Computer condition were told that if they wanted to conduct a Google Search they would have to stand up, walk over to the computer, and perform their search there. Participants in the iPod condition were told that they would have to stand up, walk over the same location, but then perform their search using an iPod touch which was placed adjacent to the computer. In both conditions, if a participant did use Google Search to answer a given question, they were then instructed to return to the sofa and wait for the next question, thereby requiring them to have to get up again to use Google Search on any subsequent trial.

Results

The proportion of questions on the second set for which participants used Google Search was analysed using a 2 (Condition: Internet vs. Memory) × 2 (Device: Computer vs. iPod) between-subjects ANOVA. Replicating Experiment 1a, participants used Google significantly more often in the Internet condition ($M = 62\%$, SE = 4%) than in the Memory condition ($M = 48\%$, SE = 3%), $F(1, 76) = 6.76$, MSE = .06, $p = .01$, $d = .57$, $CI_{95\%} = [.03, .24]$.

Consistent with the idea that we made using the Internet less convenient or appealing for participants by having them sit on the sofa, participants used Google significantly less often in this experiment than they did in the comparable conditions of Experiment 1a, $F(1, 116) = 16.49$, MSE = .05, $p < .001$. Moreover, participants used Google significantly less often in the iPod condition ($M = 50\%$, SE = 4%) than they did in the Computer condition ($M = 61\%$, SE = 4%), $F(1, 76) = 4.04$, MSE = .06, $p < .05$, $d = .44$, $CI_{95\%} = [-.21, .00]$. Despite these effects, we failed to find any evidence of an interaction, both when analysing the data from Experiment 1b alone $F(1, 76) = .22$, MSE = .06, $p = .64$, and when analysing the combined data from Experiment 1a and 1b using a 2 (Condition: Internet vs. Memory) × 3 (Device: Desk/Computer vs. Sofa/Computer vs. Sofa/iPod) between-subjects ANOVA, $F(2, 114) = .39$, MSE = .05, $p = .68$. Taken together, these results replicate the results of Experiment 1a while showing that the use of the Internet as an information source can influence the future use of the Internet as an information source even when using the Internet is made increasingly inconvenient (Figure 1).

Experiment 2

Accessing information via the Internet may not only affect a person's likelihood of relying on the Internet to access other information, it may also affect the speed with which one makes the decision to rely on the Internet to access information. We explored this possibility in Experiment 2 by measuring the amount of time participants allowed to pass between when they heard a given question and when they began their Google Search. Presumably, participants who take longer to begin their Google Search do so because they are first attempting to search their own memory. We predicted that participants in the Internet condition would spend less time searching their own memory before using Google Search than would participants in the Memory condition. This hypothesis was further explored by administering a Need for Cognition (NFC) scale at the end of the experiment to assess each participant's reported propensity to seek out challenging cognitive endeavours (Cacioppo, Petty, & Kao, 1984). Although typically employed as a trait measure, the experience of relying on the Internet could (at least temporarily) reduce the extent to which participants feel the desire to challenge themselves cognitively – which in this context could be one of the factors responsible for reducing the extent to which they bother to try to remember information without the help of the Internet. Thus, we predicted that participants in the Internet condition would report lower post-experimental NFC scores than participants in the Memory condition.

Method

Participants: Forty UCSC undergraduates participated for course credit (mean age = 20.6).

Materials and procedure: Participants were initially questioned with a set of 10 difficult trivia questions. As in the previous experiments, the questions were presented by the experimenter, with participants instructed to respond as quickly and as accurately as possible. Participants in the Internet condition were given the same instructions as in Experiments 1a and 1b – namely, to use Google Search to answer each question. Participants in the Memory condition were told to answer each question from memory.

A 5-min interval was placed between the first and second sets of trivia questions during which participants played Tetris. As in the previous experiments, the second

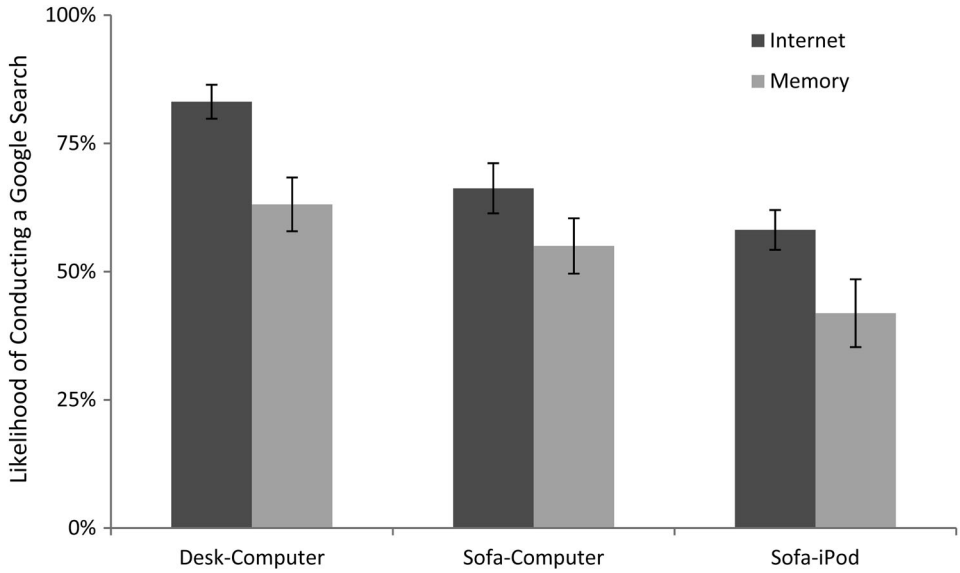

Figure 1. Likelihood of conducting a Google Search while answering the second set of trivia questions is shown as a function of experimental condition. Participants in the Internet condition used Google to answer the first set of questions. Participants in the Memory condition answered the first set of questions from memory. The left-hand columns display data from Experiment 1a in which participants were allowed to use a computer placed on a desk in front of them. The other columns display data from Experiment 1b in which participants were seated on a sofa and allowed to use either a computer (middle columns) or an iPod touch (right-hand columns) that were available on the opposite side of the room. Error bars reflect standard errors of the mean.

phase was identical for all participants. Ten relatively easy questions were read out loud one at a time and participants were instructed to answer each question as quickly and as accurately as possible. Participants were told that although they were allowed to use Google Search to find answers, they were not required to do so. As in Experiment 1a, participants remained in the same seat they were in while answering the first set of questions and were given the opportunity to use the computer to conduct their searches. In addition to recording the use of Google Search, we also recorded the time participants took to either respond with an answer or touch the mouse/keyboard to commence a Google Search. Participants were instructed to keep their hands away from the mouse and keyboard while listening to each question, thus allowing us to measure the amount of time between the end of each question and the beginning of a Google Search.

Finally, after completing the second set of trivia questions, participants were administered the NFC scale (Cacioppo et al., 1984) to assess each individual's tendency to seek out and enjoy challenging cognitive endeavours. A total of 18 items were rated on a scale of 1–5 (extremely uncharacteristic to extremely characteristic), with half of the items reverse coded. Positive scores indicate a high amount of NFC, whereas negative scores indicate a low amount of NFC. After completing the scale, participants were debriefed and granted credit for their participation.

Results

Likelihood of conducting a Google Search. The proportion of questions on the second set for which participants used Google Search is shown as a function of condition in the left-hand panel of Figure 2. As can be seen, a significant effect was observed such that participants in the Internet condition ($M = 83\%$, $SE = 4\%$) used Google significantly more often than participants in the Memory condition ($M = 60\%$, $SE = 6\%$), $t(38) = 3.29$, $p = .002$, $d = 1.04$, $CI_{95\%} = [.09, .37]$.

Time between hearing a question and conducting a Search: The mean amount of time participants took to commence a Google Search is shown as a function of condition in the middle panel of Figure 2. We focus our analysis on the amount of time it took participants to conduct a Google Search because a significant number of participants failed to answer even a single question from memory, and the propensity to do this differed by condition (30% of participants in the Internet condition, compared to only 10% of participants in the Memory condition). All participants used Google to answer at least one question. Participants in the Internet condition ($M = 2.22$s, $SE = .26$s) touched the keyboard/mouse significantly faster than participants in the Memory condition ($M = 3.76$s, $SE = .50$s), $t(38) = 2.75$, $p = .009$, $d = .87$, $CI_{95\%} = [-2.68, -.41]$. This finding suggests that participants in the Internet condition were not only more likely to use Google than participants in the Memory condition, but that they chose to do so more quickly than participants in the Memory condition, suggesting that they took less time consulting their own memory before opting to rely on Google.

NFC: NFC scores are shown as a function of condition in the right-hand panel of Figure 2. Participants in the Internet condition ($M = 3.2$, $SE = 1.8$) exhibited significantly lower NFC scores than participants in the Memory condition ($M = 12.2$, $SE = 2.0$), $t(38) = 3.39$, $p = .002$, $d = 1.07$,

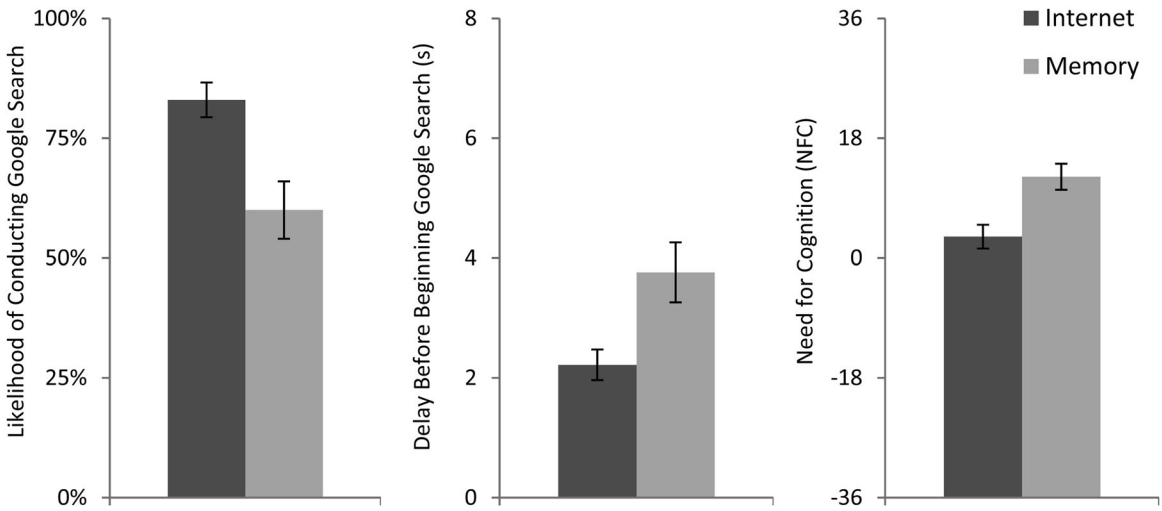

Figure 2. Data from Experiment 2 are shown as a function of condition. The left-hand panel shows the mean proportion of trials in which participants used Google to answer the second set of questions. The middle panel shows the mean amount of time participants hesitated after hearing a question before commencing a Google Search (when they conducted a Google Search). The right-hand panel shows the mean NFC scores. Error bars reflect standard errors of the mean.

$CI_{95\%} = [-3.6, -14.4]$. Because NFC is believed to reflect a relatively stable trait variable, this difference seems more likely attributable to a temporary or context-specific shift in motivation for engaging in difficult cognitive tasks (as a consequence of relying on the Internet to access information) than to a long-lasting or general change in NFC.[2]

Discussion

The present results suggest that using the Internet as an information source influences the extent to which a person uses the Internet as an information source in the future. Participants instructed to answer one set of trivia questions with the help of the Internet were significantly more likely to answer a new, relatively easier, set of trivia questions with the help of the Internet than were participants instructed to answer the first set from memory. This effect was observed in multiple conditions, an effect which persisted across a short delay and even in situations where using Google was relatively inconvenient (i.e., when participants had to get up off a sofa and use an old iPod instead of a desktop computer).

A similar effect was also observed in the way of reaction times. The time between being asked a question and pressing the mouse or keyboard to begin a Google Search was significantly shorter in the Internet condition that it was in the Memory condition. This result suggests that using the Internet to access information not only makes someone more likely to rely on the Internet to access information in the future than they would have been otherwise, but that the decision to do so is made more quickly than it would have been otherwise. Participants commenced their Google Search almost twice as fast in the Internet condition than in the Memory condition, suggesting that they were less likely to conduct a thorough search of their own memory before opting to rely on Google to retrieve the answer. Consistent with this possibility is the observation that participants in the Internet condition reported significantly lower post-experiment NFC scores than participants in the Memory condition. It appears that being instructed to conduct only a handful of Google Searches can be sufficient to temporarily reduce a person's desire to engage in challenging cognitive behaviours.

Many questions remain regarding the nature of the findings observed in the present research. At a general level, the findings suggest that using a particular information source – in this case, the Internet – influences the likelihood of using that source again in the future. It remains to be seen, however, whether this increased reliance on the Internet is in any way different from the type of increased reliance one might experience on other information sources, such as books or people. It is possible that certain aspects of the Internet, such as its vastness, depth, and reliability – which can be compared to the much more limited and fallible aspects of human memory (Schacter, 2001) – make becoming reliant on the Internet particularly useful. Although accessing information via the Internet undoubtedly involves the possibility of encountering false information, the Internet also has the benefit of being continuously updated to reflect the accumulation of new knowledge (Arbesman, 2012). When accuracy is paramount, and when the Internet is available and its use is contextually appropriate, one might often be better off relying on the Internet than not. Indeed, participants in the present research were more accurate in their responses to the trivia questions when they conducted a search than when they did not. Despite these considerations, however, future work will be necessary to determine whether the dynamics involved

in becoming reliant on the Internet as an information source are in anyway different from those involved in becoming reliant on other information sources.

It is also worth noting that the costs and benefits of altering one's reliance on the Internet are likely to vary as a function of a number of factors, including an individual's expertise within a domain. Although the Internet may be effective in helping people access certain types of information, it may be much less effective in helping people access other types of information. In such cases, using the Internet to access information could prove detrimental. Furthermore, there are forms of expertise that require the possession of vast amounts of knowledge and the ability to rapidly and flexibly use that information is unlikely to be attained when it is stored externally (Benjamin, 2008). Delineating the costs and benefits of using the Internet as an information source represents an important direction for future research (for a relevant discussion, see Nestojko, Finley, & Roediger, 2013).

The present study provides an example of how using the Internet as an information source potentiates the future use of the Internet as an information source, but it stands to reason that such an effect is likely to occur in many other contexts as well. Indeed, similar effects seem likely to eventually (if not already) permeate every facet of our cognitive lives. As the Internet accumulates more information – not only about facts and general knowledge, but also about our personal lives and social networks – and as it becomes increasingly available via smartphones and other household devices, we have the potential to become progressively more reliant on it in our daily lives. Understanding the ways in which people experience this increased reliance, and the ways in which they use technology to offload memory and cognition more generally, will be paramount in building models of how memory functions in natural settings. Memory has been extended, and as such, so must the reach of the paradigms we use to investigate it.

Notes

1. Trivia performance is reported here collapsed across all three experiments. For difficult questions (Set 1), participants in the Internet condition ($M = 90\%$, $SE = 1\%$) outperformed participants in the Memory condition ($M = 19\%$, $SE = 2\%$), $t(158) = 29.11$, $p < .001$, $d = 4.60$. For easy questions (Set 2), participants in the Internet condition ($M = 88\%$, $SE = 2\%$) outperformed participants in the Memory condition ($M = 79\%$, $SE = 2\%$), $t(158) = 3.59$, $p < .001$, $d = .57$. This difference in trivia performance can likely be attributed (at least in part) to participants conducting more Google Searches in the Internet condition than in the Memory condition.
2. Twenty additional participants took part in a third condition identical to the Memory condition except that they received feedback during the first phase of the experiment (i.e., they were told the correct answers to the difficult trivia questions after providing their own answers). No significant differences were observed between the Memory (Feedback) and Memory (No Feedback) conditions in any measure of interest (all p values were $> .05$) and all comparisons with the Internet condition remained significant when the two Memory conditions were combined. For purposes of brevity and directness, and to facilitate comparisons with Experiments 1a and 1b, we opted to report only the Memory (No Feedback) condition. In case readers are interested, however, participants in the Memory (Feedback) condition performed a Google Search 46% ($SE = 4\%$) of the time, conducted their search after an average of 4.48s ($SE = .55$s), and reported NFC scores of 7.8 ($SE = 3.1$).

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Difficult Trivia Questions (Set 1)

Who was the King of England during the American Revolution?
What was the first American state to secede from the union?
What happened on October 29, 1929?
What did King John sign in 1215?
Who became president after John F. Kennedy was assassinated?
In what city does the play, "My Fair Lady" take place?
In what state have the most presidents been born?
What country destroyed the Spanish Armada in 1588?
What is a baby elephant called?*
On what race track is the Kentucky Derby run?*

Easy Trivia Questions (Set 2)

How many events are there in an Olympic decathlon?
What machine is used to weave?
What sport uses a foil?
What is the centre of a hurricane called?
What is a baby goat called?
What country attacked the Alamo?
What does an "entomologist" study?
How many zodiac signs are there?
What was Picasso's first name?*
What is Big Ben?*

Note: Questions with asterisks were used only in Experiment 2.