



The Influence of Feeling-of-Knowing on Metacognitive Processes in the Digital Media Environment

Zijian Lew¹ and Andrew J. Flanagin²

¹Wee Kim Wee School of Communication and Information, Nanyang Technological University, Singapore

²Department of Communication, University of California, Santa Barbara, CA, USA

Abstract: Research demonstrates that people outsource memory work to digital devices and to the web, which consequently engenders elevated self-assessments, such as enhanced cognitive self-esteem (CSE). Yet, the reasons for this phenomenon are not well-known. In this domain, two studies explored the role of feeling-of-knowing (FoK) – one’s judgment about whether currently nonrecallable information is actually known – on enhanced CSE. Findings show that people believe that their ability to find needed information is better after performing a web search for answers, as a function of elevated FoK that occurs in the process, and that experiencing greater FoK is related to greater perceived memory ability, better anticipated future performance, and easier perceived question difficulty. Evidence of this metacognitive effect is particularly intriguing since it is also highly paradoxical: under precisely the circumstances when people should recognize their cognitive shortcomings, they assess them to be especially strong.

Keywords: feeling-of-knowing, metacognition, cognitive self-esteem, knowledge

When Clark and Chalmers (1998) proposed the “extended mind,” they described a fictitious Alzheimer’s patient, Otto, who regularly writes in a notebook and then consults the notebook when he needs to recall information. Otto’s notebook is a cognitive extension compensating for his unreliable brain. A newer explication of the extended mind idea (Heersmink, 2016) highlights how this notion has become more important over time as the Internet and digital devices perform increasingly larger roles in contemporary life. For example, people rely on digital calendars to remind them of tasks and appointments, regularly seek information from the web when curious or in doubt, use digital navigation tools to drive, and routinely take photographs with their mobile phones. Such uses of digital tools free up and alter people’s short- and long-term memories, augment their experiences, and prompt metacognitive recalibration of their own and others’ capabilities (Heersmink, 2016; Marsh & Rajaram, 2019). Scholars have even argued that never in human history has there been a tool that can partner with and extend the human mind as extensively as digital devices can today (Heersmink, 2016; Ward, 2013a, 2013b). Like McLuhan’s (1964/1994) claim that media are extensions of ourselves, this view holds that human cognition is irrevocably changed by digital media and digital devices.

Several studies provide evidence that the human mind is coupled with – and extended by – digital devices. For instance, Sparrow et al. (2011) demonstrated that people are primed to search the web when they have a need for information, and that people remember where to find information but not what the information is. Storm et al. (2017) found that people can grow reliant on Google and may even prefer to search Google than search their own memories for basic information that they almost surely know. Sloman and Rabb (2016) showed that people will believe they have greater understanding of a phenomenon if they are told that an explanation for the phenomenon exists on the web than if they are told that the explanation does not exist on the web – even if the phenomenon is completely fictitious.

One line of research to emerge from such studies shows that the coupling of the human mind with digital devices can result in a conflation between internal and external knowledge – people erroneously believe they possess, in their own heads, information from the web (Fisher & Oppenheimer, 2021a). Moreover, ostensibly because people conflate/misattribute the source of knowledge, they think more highly of themselves after searching the web than after not searching the web. For example, people who searched the web for information evaluated themselves as

having better memory ability, greater intelligence, and better information searching ability (collectively termed *cognitive self-esteem* [CSE]; Ward, 2013a, 2021) than people who did not search the web. Other studies have similarly shown that knowledge source misattribution can make people overconfident, due to actively searching for information (Fisher et al., 2015), familiarity with the device used for searching (Hamilton & Yao, 2018), and search fluency (Flanagin & Lew, 2023).

Yet, it is unclear whether technology is a central cause or merely a facilitator of knowledge source misattribution. When people are faced with a question they do not have an answer to, they may have a *feeling-of-knowing* (FoK), defined as an assessment of “whether a given currently nonrecallable item is known” and can be recalled in the future (Nelson & Narens, 1990, p. 130). Some scholars have argued that experiencing a FoK for information – followed by the rapid retrieval of that information from the web, which confirms their FoK – leads to downstream effects like greater CSE (Fisher et al., 2015; Ward, 2021). In other words, searching the web leads to increased CSE only because it allows people to confirm a FoK that they initially have. From this perspective, FoK is a necessary condition for elevated CSE, and other factors – such as active search, device familiarity, or cognitive processing fluency – merely facilitate elevated CSE. However, FoK has to date not been tested in studies examining knowledge source misattribution or elevated CSE. And if FoK is indeed a prerequisite for knowledge source misattribution, then technology is a facilitator – not a cause. The current technologically deterministic view may be too simplistic.

Furthermore, FoK is crucial for learning: People make monitoring judgments when they are learning, and one such judgment is FoK (Nelson & Narens, 1990). For example, after people do not know how to answer a question, they use their FoK to decide what to restudy, often focusing on areas where they have relatively higher FoK (Hanczakowski et al., 2014). People also use their FoK to decide how long they search their memories for needed information (Singer & Tiede, 2008). If searching the web interferes with FoK, it could therefore lead to inefficient learning as people make poor decisions or misallocate their time. The two studies described herein therefore aim to study FoK as an underlying mechanism explaining the connection between digital media use and elevated CSE, in the context of digital information search.

Searching the Web Increases Cognitive Self-Esteem (CSE)

CSE is a subjective assessment of one’s own cognitive abilities on three dimensions: memory ability (CSE_{mem}), thinking ability/intelligence (CSE_{think}), and ability to search for

information within a transactive memory system (CSE_{TM}). A transactive memory system is a collaborative group in which individuals are responsible for remembering information in their own domains of expertise while being able to query domain experts for information when needed (Wegner, 1987). In the present context, the web is metaphorically considered the “expert” and CSE_{TM} refers to one’s subjective self-assessed information searching skills.

Some proposed reasons why people might experience greater CSE after searching the web focus on the unique qualities of the web (Marsh & Rajaram, 2019). For example, the web is highly accessible via Internet-capable mobile phones and, relative to past information-seeking behaviors (e.g., searching the index of an encyclopedia), entering keywords into a search engine is simple, fast, and habitual, and therefore more cognitively fluent (see Stone & Storm, 2021). Additionally, the web’s breadth and depth of information vastly extend its perceived capabilities (Ward, 2013b). The omnipresence of the web, the cognitive fluency when searching it, and the tremendous amount of information it contains make the web more accessible than other external memory storage media, potentially rivaling the accessibility of information stored in people’s own heads (Ward, 2013a, 2021).

Based on these qualities of the web, researchers (Fisher et al., 2015; Hamilton & Yao, 2018; Ward, 2013a) have proposed a two-part argument regarding why searching the web elevates CSE. First, because the web is so highly accessible, it feels like an extension of one’s mind. Similar to tools like a prosthetic limb or a pair of glasses, the web can also feel like it is a part of oneself through various digital devices like a smartwatch, a mobile phone, or a computer. The psychological boundary between internal knowledge (inside-the-head) and external knowledge (web-based) is thus blurred when people search the web for information, facilitating the erroneous perception that one internally possesses knowledge that is in reality external. Second, because the web contains a substantial amount of information, people who conflate internal and external knowledge may overestimate the amount of knowledge and CSE they possess internally.

Several studies support these claims. In an experiment by Ward (2013a, Study 2), participants were presented with 10 open-ended trivia questions. They were instructed: (a) to Google for the answers while answering the trivia questions, (b) *not* to Google for answers while answering the trivia questions, or (c) they were not given any additional instruction. After answering the trivia questions, participants who Googled for answers reported greater CSE than participants who did not Google as well as participants who did not receive additional instructions, suggesting that people conflate internal and external knowledge after searching the web, and subsequently overestimate their own

cognitive abilities. This study was replicated by Hamilton and Yao (2018), who additionally found that the effect of Googling for answers on CSE was magnified if the digital device used was familiar to the user. Finally, across several experiments, Fisher et al. (2015) found that people who searched the web for trivia answers rated themselves as more knowledgeable than people who did not search the web.

However, a rival explanation is that hindsight bias (Fischhoff & Beyth, 1975) increases CSE. Defined as “the tendency to overestimate in hindsight what one has known in foresight” (Pohl et al., 2002, p. 270), hindsight bias is known to result in overconfidence across a variety of situations (see Roese & Vohs, 2012 for review). In the current context, being provided with answers via *any* means may result in greater CSE; after having learned the answers, people may then rate their own CSE more highly in hindsight. Thus, this study assesses FoK explicitly while examining the effect of searching the web for answers – versus being provided with answers – in order to assess the combined roles of FoK and searching the web on CSE, while attempting to eliminate the potential influence of hindsight bias.

Based on the foregoing, the blurring of boundaries between internal and external knowledge implies that searching the web for answers should engender greater CSE than not searching the web. To eliminate hindsight bias as an explanation, searching the web for answers should also engender greater CSE than passively receiving answers.

What is less clear, however, is whether web searches influence the three dimensions of CSE differentially. If people believe that the information they found on the web resides within themselves, their errors in self-judgment should have internal foci – and thus influence CSE_{think} and CSE_{mem} (Ward, 2021). But if people believe that the information they found on the web resides outside of themselves, their errors in self-judgment should have an external focus, namely CSE_{TM} – which deals with people’s confidence in their own ability to search for information (Ward, 2021). It is therefore important to empirically disentangle these dimensions. Thus:

Hypothesis 1 (H1): Searching the web for answers leads to greater CSE_{think} , CSE_{mem} , and CSE_{TM} than (a) passively receiving answers and (b) not searching the web and not receiving answers.

Qualities associated with digital technology and how people use digital technology have played prominent explanatory roles in the extant research. Yet, if technological reasons were all that mattered, the conclusion to the line of reasoning provided thus far is that people would regularly overestimate their own cognitive abilities because searching the

web is a frequent activity in daily life. However, preliminary theorizing (Ward, 2013a, 2021) actually suggests that this phenomenon is conditional upon a psychological factor, feeling-of-knowing (FoK), and may be applicable only to very specific circumstances. Though this explanation has been asserted, it has not yet been tested.

Feeling-of-Knowing (FoK)

FoK is potentially an important prerequisite for searching the web to result in inflated CSE. Ward (2013a) argued that if people experience FoK regarding certain questions, searching the web for answers confirms the FoK, creating the illusion that their FoK was right and that they knew the answers all along. This is an important qualification: not all web searching will cause inflated CSE. Rather, FoK must be experienced prior to searching for information, and only then will people experience inflated CSE. However, FoK was inferred – but not measured – in Ward’s (2013a, 2021) experiments. Fisher et al. (2015) also seemed to implicitly acknowledge the importance of FoK, as shown from their experimental procedure: participants were instructed to “confirm the details” by searching the web (p. 676). As Fisher et al. (2015) explained “The idea was that participants should have some sense of the answers they were searching for, such that they might more readily and consistently inflate their internal knowledge with the knowledge they were accessing” (p. 676). However, Fisher et al. (2015) also did not elaborate on this decision at a theoretical level.

The clearest support for the potential role of FoK in elevating CSE comes from Ward’s (2021, Experiment 7) study, where participants answered trivia questions of easy, medium, or hard difficulty, either using Google or not. Participants who answered medium difficulty trivia questions while always Googling for answers reported greater CSE than participants who answered medium difficulty questions while never Googling for answers. Ward (2021) argued that easy and hard trivia questions produced very little FoK: in both cases it was clear to participants that they did or did not know the answers. Medium difficulty questions, however, were posited to produce the most FoK (and, in turn, greater CSE) because participants were more likely to believe that they had the answers in their heads, even if they did not. Under these circumstances FoK – though it was not actually measured in this study – was proposed as the mechanism inciting elevated levels of CSE.

Although Ward’s (2021) inference that FoK is the mechanism that amplifies CSE is plausible, it conflated FoK with actual knowledge. Ward (2021) argued that easy trivia questions could produce little FoK because participants could confidently answer them all. Thus, the easier the *answered* questions, the lower FoK one should experience. However,

if participants were unable to answer an easy question, they could experience even more FoK than with the medium or hard difficulty questions. Thus, the easier the *unanswered* questions, the greater FoK one should experience. To disentangle actual knowledge from FoK requires the consideration of FoK *only* for questions that one *cannot* answer, which is a critical factor that the current study addresses procedurally. Put differently, contrary to Ward's (2021) argument that easy questions engender little FoK because they are *answered* and difficult questions engender little FoK because they are *unanswered*, the present study posits that easy *unanswered* questions should engender the greatest FoK ("I should know this!"), followed by medium-difficulty *unanswered* questions ("I might know this"), and difficult *unanswered* questions, which should engender the least FoK ("There's no way I know this").

Based on the results of Ward's (2021) study described earlier, but separating FoK from actual knowledge by focusing only on unanswered questions, there should be an indirect effect of question difficulty on cognitive self-esteem through FoK, *conditional on* the method of answer derivation. Compared to harder questions, progressively easier questions should engender greater FoK, which in turn leads to greater cognitive self-esteem, but only if (a) one searches the web for answers – and not if (b) one passively receives answers or if (c) one does not search the web and does not receive answers. Thus:

Hypothesis 2 (H2): Easier questions engender greater feeling-of-knowing, which (as a mediator) engenders greater CSE_{think}, CSE_{mem}, and CSE_{TM}, but only when people search the web for answers.

Pretest

A pretest was conducted with US participants recruited through Amazon's MTurk ($N = 715$) to determine the relative perceived difficulty of 97 trivia questions originally used in Ward (2013a). The rankings of the perceived difficulty of these trivia questions were used to derive hard, medium, and easy difficulty questions for Studies 1 and 2. Details of the pretest procedure and results can be found in the Electronic Supplementary Materials, ESM 1 and 2.

Study 1

Procedure and Sample

Study 1 was a 3 (question difficulty: easy/medium/hard) \times 3 (method of answer derivation: search web for answers/answers provided/control) between-subjects experiment.

Participants were instructed that they would be answering some trivia questions, and that payment was not contingent on the number or correctness of their responses. Participants were then told that they must answer with the information "already in your head only" and therefore were instructed *not* to use a search engine to look up answers to any of the trivia questions. To minimize the temptation to search for answers at this stage, participants were informed that at the completion of the task they would be provided with all trivia question answers.

Participants were randomly placed into one of three (easy, medium, or hard) question difficulty conditions and then presented with trivia questions of that difficulty, one by one. As each trivia question was presented participants had to either type their answer or indicate that they "can't think of the answer right now." A maximum of 10 trivia questions (randomly counterbalanced in presentation order) was displayed within each difficulty condition.

Because FoK is by definition present only when a participant does not know the answer to a question, a certain number of unanswered questions was necessary in this study. The number of unanswered trivia questions sufficient to invoke FoK, however, is unknown: At one extreme, a small number of unanswered questions may not invoke sufficient FoK, while at the other extreme FoK could be undermined if one cannot answer a large number of trivia questions. Given these considerations, the number of unanswered questions to successfully invoke FoK was set in advance of data collection at 5, which was deemed sufficient to invoke FoK but not so great as to destabilize it.¹ Therefore, participants were presented with trivia questions, one by one, until they failed to provide an answer to 5 questions, at which point they were brought to the next phase of the study. Conversely, if participants did not reach 5 unanswered questions by the time all 10 questions were shown, they were excluded from analyses.

Next, participants were re-presented with the group of 5 questions that they previously could not answer. They were then instructed to provide their FoK for all the re-presented questions, as a group. Participants were then randomly assigned to one of three conditions for the method of answer derivation. In the web search condition ($n = 69$), participants were instructed to "use the search engine of your choice (i.e., Google, Bing, Yahoo, etc.) to look up answers to the questions you did not answer before." Participants then entered the answers they found and were brought to the post-test questionnaire. In the answers provided condition ($n = 89$), participants were shown the answers to the questions they did not answer, thereby obtaining answers without searching the web, and were subsequently brought to the post-test questionnaire. In the

¹ Pilot tests with a sample independent from the current study indicated that 5 questions appeared to be a reasonable threshold.

control condition ($n = 93$), participants were brought straight to the post-test questionnaire after indicating their FoK. The post-test questionnaire included the CSE measures and demographic questions.

US-based participants (recruited via MTurk) responded to 2 simple attention check questions and indicated after the study if they had used a search engine when instructed not to do so (or before being instructed to do so in the web search condition); participants were eliminated from the study based on these criteria and, as noted earlier, participants who did not answer at least 5 trivia questions were ineligible for this study. Notably, the “easy” question difficulty condition had a negligible sample size ($n = 2$), as very few participants indicated that they did not know answers to a sufficient number of the “easy” questions. Consequently, results for this condition were deemed to be of little value and this condition was omitted from all analyses. These procedures resulted in $N = 249$ valid participants.² Among the 249 participants, 51.4% were male, 48.2% were female, and 0.4% declined to indicate their biological sex. 74.7% were White, 9.1% were Asian, 7.9% were Black, 5.0% were Hispanic/Latino, 0.8% were American Indian or Alaska Native, and 3.3% had mixed ethnicity. The mean age was 36.3 years old ($SD = 11.5$).

Measures

FoK was measured using 4 original items, pilot-tested with a sample independent from the current study: “Although I cannot recall them right now, I have a feeling I know the answer to these questions,” “I don’t think I’d be able to answer these questions even if I had more time to think about them” (reverse coded), “I believe the answers to these questions would come to me if I took some time to think about them more,” and “The answers to these questions are on the tip of my tongue.” Responses ranged from 1 (= *strongly disagree*) to 5 (= *strongly agree*), Cronbach’s $\alpha = .90$.

The cognitive self-esteem measure (Ward, 2013a) had three dimensions. The *thinking* dimension (CSE_{think}) comprised 6 items, including “I am smart” and “My mind is one of my best qualities,” Cronbach’s $\alpha = .86$. The *memory* dimension (CSE_{mem}) consisted of 4 items, including “I am proud of my memory” and “I feel good about my ability to remember things,” Cronbach’s $\alpha = .87$. The *transactive memory* dimension (CSE_{TM}) was made up of 4 items, including “When I don’t know the answer to a question right away, I know where to find it” and “I have a knack for tracking down information”. Cronbach’s $\alpha = .69$.

Responses ranged from 1 (= *strongly disagree*) to 5 (= *strongly agree*). See Appendix A in ESM 1 for confirmatory factor analyses results and all items.

Results

To test H1, a MANOVA was performed to test the effect of method of answer derivation on the 3 dimensions of cognitive self-esteem. Box’s test was non-significant, Box’s $M = 13.63$, $F(12, 253368.61) = 1.12$, $p = .34$ – therefore, homogeneity of variance-covariance matrices can be assumed. The multivariate result was not significant, Wilks’s $\lambda = .99$, $F(6, 488) = .25$, $p = .96$, $\eta_p^2 = .003$. Levene’s test was non-significant at the univariate level for CSE_{think} , $F(2, 246) = 0.17$, $p = .85$, CSE_{mem} , $F(2, 246) = 0.77$, $p = .47$, and CSE_{TM} , $F(2, 246) = 0.24$, $p = .79$. Therefore, univariate homogeneity of variances can be assumed. Univariate results were not significant for the thinking dimension, $F(2, 246) = .38$, $p = .69$, the memory dimension, $F(2, 246) = .03$, $p = .97$, or the transactive memory dimension, $F(2, 246) = .60$, $p = .55$. H1 was not supported.

H2 predicted that FoK mediates the relationship between question difficulty and CSE, but only if people search the web for answers. Three moderated mediation analyses were performed using PROCESS (Hayes, 2018) Model 14 with question difficulty (using medium and hard conditions only, as noted earlier³) as the predictor, FoK as the mediator, and each of the 3 CSE measures as the outcome. Method of answer derivation was modeled to moderate the relationship between FoK and each outcome. Using PROCESS, medium question difficulty was coded as 0 and hard question difficulty was coded as 1. Dummy codes were created by PROCESS for method of answer derivation, with the “search the web” condition as the reference category. The path from question difficulty to FoK was significant, $R^2 = .09$, $F(1, 247) = 24.76$, $p < .001$. The medium difficulty questions engendered greater FoK than the hard questions, $b = -.686$, $SE = .138$, 95% CI = $[-.958, -.415]$.

Results for the relationship between FoK and each outcome variable, conditional on the method of answer derivation, are reported in Table 1. Indirect effects were interpreted using the bootstrapped 95% confidence intervals (10,000 bootstrapped samples). There was no conditional indirect effect of question difficulty on CSE_{think} or CSE_{mem} . There was, though, a conditional indirect effect of question difficulty on CSE_{TM} through FoK when participants searched the web for trivia answers ($b = -.178$, bootstrapped $SE = .065$, bootstrapped 95% CI = $[-.316, -.059]$), but not when participants were provided with

² Approximately 174 participants are needed to detect effects at 80% power, assuming a small-to-medium effect size ($f^2 = .04$).

³ Analyses of Study 1 data with other criteria for inclusion into the difficulty conditions (i.e., fewer than 5 unanswered questions as means of inclusion into the various “difficulty” conditions) indicated results that were substantially similar to those described herein for H1 and H2.

Table 1. Results of moderated mediation analysis

Outcome variable Y	W	Effect of X on M (a)	Effect of M on Y (b)	Indirect Effect (a × b)	Bootstrapped SE	Bootstrapped 95% CI
CSE _{think} : $R^2 = .018$, $F(6, 242) = .76$, $p = .605$	Search the web	-.686	.100	-.069	.076	[-.231, .070]
	Answers provided		-.058	.040	.080	[-.119, .203]
	Control		-.038	.026	.057	[-.089, .142]
CSE _{mem} : $R^2 = .026$, $F(6, 242) = 1.06$, $p = .390$	Search the web	-.686	.225	-.155	.104	[-.385, .026]
	Answers provided		.190	-.130	.112	[-.371, .079]
	Control		.007	-.005	.071	[-.143, .144]
CSE _{TM} : $R^2 = .067$, $F(6, 242) = 2.88$, $p = .010$	Search the web	-.686	.259	-.178	.065	[-.316, -.059]
	Answers provided		.138	-.094	.066	[-.227, .037]
	Control		.020	-.014	.049	[-.112, .085]

Note. Y = outcome variable, W (moderator) = method of answer derivation, X = question difficulty, M (mediator) = feeling-of-knowing. R^2 , F , and p values refer to the models where the outcomes were predicted by a linear combination of question difficulty + feeling-of-knowing + method of answer derivation + feeling-of-knowing × method of answer derivation.

answers ($b = -.094$, bootstrapped $SE = .066$, bootstrapped 95% CI = [-.227, .037]) or when participants were in the control condition ($b = -.014$, bootstrapped $SE = .049$, bootstrapped 95% CI = [-.111, .085]). Additionally, there was a significant difference between the moderated mediation effect conditional on searching the web (i.e., “search the web” condition) and the moderated mediation effect conditional on not searching for or receiving answers (i.e., “control” condition); index of moderated mediation = .164, bootstrapped $SE = .075$, bootstrapped 95% CI = [.029, .323]. Therefore, H2 was supported only for CSE_{TM}.

Discussion and Rationale for Study 2

Study 1 found that FoK is necessary for searching the web to engender an inflated sense of CSE_{TM}. Findings demonstrate that among questions one is unable to answer, easier unanswered questions (i.e., of medium difficulty) trigger greater FoK than more difficult (“hard”) unanswered questions. Additionally, searching the web after having experienced greater FoK rather than lower FoK results in higher CSE_{TM}. The conditional indirect effect between question difficulty and CSE_{TM} through FoK when participants searched the web for trivia answers indicates that the indirect effect for CSE_{TM} is mainly a product of the process of searching the web for information. Thus, people appear to believe that their ability to find needed information is better after seeking answers they did not know via a web search, as a function of elevated FoK that occurs in the process.

Study 1 provided initial evidence that FoK plays a role in particular aspects of elevated CSE. Yet, as mentioned, the partially failed manipulation (i.e., requiring 5 questions to remain unanswered to invoke FoK was too stringent in the “easy” difficulty level) also demonstrates the challenge of appropriately assessing FoK. Consequently, the shortcomings of, and findings from, Study 1 are leveraged to fashion a follow-up quasi-experimental study to further examine the role of FoK in digital extended cognition. To

further isolate, probe, and extend Study 1’s results, Study 2 offers a novel, revised strategy for measuring FoK that better captures its inherent cognitive in-the-moment nature, includes additional outcomes that add deeper understanding to the effects of FoK, and focuses on the theoretically-relevant factors validated by Study 1 that may explain differences in CSE and related concepts.

Specifically, in Study 1 participants reported a single FoK score for all unanswered questions collectively, upon revisiting them as a group. Yet, each unanswered question can engender its own level of FoK and, additionally, participants would have also experienced FoK upon their first exposure to the unanswered trivia questions. Study 2 addresses these considerations by measuring FoK (a) in a question-specific fashion (i.e., FoK for each unanswered question and not for the group of unanswered questions as a whole) and (b) in-the-moment (i.e., when participants see a question for the first time).

Additionally, to complement CSE, 3 additional dependent variables were introduced in Study 2: *perceived question difficulty*, *anticipated future performance*, and *perception of the web as a knowledge partner*. Perceived question difficulty was introduced because participants could plausibly form judgments regarding the trivia questions that may be reflective of, but not necessarily completely commensurate with, their own CSE (see Efklides, 2006 for review on feeling of difficulty in metacognition research). Searching the web should result in a perception of lower question difficulty than not searching the web. Anticipated future performance, which was used as an outcome measure in Ward (2013a, 2021), asked participants to judge how well they expect to perform on a future trivia quiz of similar difficulty. Searching the web should lead to better anticipated future performance than not searching the web. Perception of the web as a knowledge partner, a novel construct created to test the proposition by several researchers (e.g., Hamilton & Yao, 2018; Kahn & Martinez, 2020; Ward, 2013a) that the Internet metaphorically functions as a transactive memory

partner, asked participants to what extent they thought the web was like a transactive memory partner. Searching the web should lead to greater perception of the web as a knowledge partner than not searching the web. Formally:

Hypothesis 3 (H3): High FoK leads to (a) greater CSE_{think} , CSE_{mem} , and CSE_{TM} , (b) lower perceived question difficulty, (c) better anticipated future performance, and (d) greater perception of the web as a knowledge partner than low FoK.

Hypothesis 4 (H4): Searching the web for answers leads to (a) greater CSE_{think} , CSE_{mem} , and CSE_{TM} , (b) lower perceived question difficulty, (c) better anticipated future performance, and (d) greater perception of the web as a knowledge partner than passively receiving answers and not searching the web and not receiving answers.

Hypothesis 5 (H5): There is an interaction effect between FoK and method of answer derivation, such that having high FoK and searching the web for answers leads to (a) greater CSE_{think} , CSE_{mem} , and CSE_{TM} , (b) lower perceived question difficulty, (c) better anticipated future performance, and (d) greater perception of the web as a knowledge partner than any other combination of FoK and method of answer derivation.

Because its primary role in Study 1 was as an experimental induction to foster greater or lesser FoK in participants, and it failed to illicit differences in CSE, question difficulty was not manipulated in Study 2 (though as noted perceived question difficulty was included as a new, potential outcome). FoK was a measured independent variable in the quasi-experimental design of Study 2. Method of answer derivation remains theoretically relevant and was therefore retained as an independent, randomly-assigned variable since its effect was partially validated in Study 1. Study 2 thus took the form of a 3 (method of answer derivation: web search/answers provided/control) \times 2 (FoK: high/low) between subjects quasi-experimental design.

Study 2

Sample and Procedure

US-based participants were recruited through MTurk and, following Ward (2013a), were at the study's outset asked to describe their surroundings and any other activities they were involved in during the trivia task. Participants also responded to 2 simple attention checks. Those who were

clearly significantly distracted (e.g., "currently watching a YouTube video while doing this study" or "listening to my 6 year old who is homeschooled read aloud"), or who failed the attention check items, were eliminated from the study, as were those who reported after the study that they had used a search engine during the study when instructed not to do so (or before being instructed to do so in the web search condition). An additional 5.2% of participants were eliminated due to a technical issue with the questionnaire. This resulted in 268 valid participants in the study ($N = 268$).⁴ Among the 268 participants, 48.5% were male, 50.7% were female, and 0.8% declined to indicate their biological sex. 79.5% were White, 10.4% were Black, 4.1% were Asian, 1.9% were Hispanic/Latino, 0.4% were American Indian or Alaska Native, 0.4% were Middle Eastern, and 3.7% had mixed ethnicity. The mean age was 36.7 years old ($SD = 11.6$).

Participants were instructed they would be asked to respond to 15 trivia questions, one at a time. These questions straddled the middle of the question difficulty rankings in the pretest – and thus could be considered medium difficulty (see *ESM 2* for details). The number of trivia questions was increased from Study 1 due to the large number of participants therein who did not meet the minimum number of unanswered questions required to reliably assess FoK. As before, participants were instructed that task payment was not contingent on the number or correctness of their responses and that at the completion of the task they would be provided with all trivia question answers. Participants were instructed to provide an answer *only* if they were certain of it and not to guess if they were not. Finally, participants were told at this stage *not* to use a search engine to look up answers to any of the trivia questions.

As participants answered the trivia questions one by one (which were randomly counterbalanced in presentation order), they were reminded of these instructions and indicated either an answer to each question or, if an answer was not known, the magnitude of their FoK for each question. From these responses, participants were categorized into either a high or low FoK group (see *Measures* section for details). Participants were then re-presented with the formerly unanswered questions for which they had indicated either high or low FoK (again, depending on their FoK group, as detailed later). Participants were then randomly assigned to one of three experimental conditions (web search, answers provided, control), and were either (a) instructed to now look up answers to these questions using the search engine of their choice, (b) provided the answers to these questions without searching, or (c) not provided the answers at this juncture, respectively. Finally,

⁴ Approximately 223 participants are needed to detect effects at 80% power, assuming a small-to-medium effect size ($f^2 = .04$).

participants completed the dependent measures, saw the answers to any trivia questions they had not answered, and were debriefed.

Experimental Conditions

For each of the 15 trivia questions where respondents were “not able to recall the answer right now,” they indicated the extent to which they felt that “the answer to this question would come to you if you took some more time to think about it more.” For each of these questions, participants indicated their FoK on a 6-point Likert-type scale (with low to high FoK ranging from -3 to $+3$), with responses of $-3 = \textit{definitely not}$, $-2 = \textit{probably not}$, $-1 = \textit{maybe not}$, $1 = \textit{maybe so}$, $2 = \textit{probably so}$, and $3 = \textit{definitely so}$. Text accompanying each choice contextualized the responses (e.g., “*Probably not*: If I thought about it more ‘I probably would not be able to’ answer this question”).

The *feeling-of-knowing condition* was derived from these feeling-of-knowing measures for each unanswered question. From these responses, FoK_{low} was calculated by averaging the absolute values of low FoK (negative) unanswered questions and FoK_{high} was calculated by averaging the absolute values of high FoK (positive) unanswered questions. Participants were categorized into either a high or low FoK condition according to the greater of the two values, FoK_{high} and FoK_{low} . No subject answered all questions. In instances where the magnitude of FoK_{high} and FoK_{low} was equal, the greater number of unanswered questions for low or high FoK was used to assign participants into conditions; in instances where both magnitude and number were equal, participants were randomly assigned into conditions.⁵

The *method of answer derivation* included a “web search” condition, wherein participants were instructed to search for answers to either the high FoK or low FoK unanswered questions (depending on FoK condition) using the search engine of their choice, an “answers provided” condition, where answers to unanswered high FoK or low FoK questions were provided without searching, and a control condition, where participants did not search the web and were not provided with answers.

Measures

CSE factors were identical to those described in Study 1 (i.e., CSE_{think} , CSE_{mem} , and CSE_{TM}). *Perceived question difficulty* was measured by asking participants to consider all the trivia questions as a whole and respond to 3 items

designed to assess their difficulty, e.g., “I had a hard time answering the trivia questions,” Cronbach’s $\alpha = .88$. *Perception of the web as a knowledge partner* was assessed by instructing participants to consider the information they can access via search engines and noting across 5 items to what extent, for instance, “having information available online is like knowing something myself,” Cronbach’s $\alpha = .71$. Both measures were scored from 1 (= *strongly disagree*) to 5 (= *strongly agree*). Anticipated *future performance* was assessed by asking participants to indicate on a slider from 0% to 100% what percentage of questions they believe they would answer correctly if they were to take another quiz of similar difficulty, without the aid of a search engine. See Appendix B in ESM 1 for a confirmatory factor analysis showing that the dependent measures have discriminant validity.

Results

Hypotheses 3–5 were analyzed using SPSS’s GLM procedure. A 3 (method of answer derivation: web search/answers provided/control) \times 2 (FoK: high/low) MANOVA was conducted with CSE_{think} , CSE_{mem} , CSE_{TM} , perceived question difficulty, perception of the web as a knowledge partner, and anticipated future performance as the dependent variables. Box’s test was non-significant, Box’s $M = 148.72$, $F(105, 5110.98) = 1.19$, $p = .09$, and thus the homogeneity of variance-covariance matrices assumption was not violated. Results showed a significant multivariate main effect of FoK on the dependent variables (Wilks’s $\lambda = .92$, $F(6, 257) = 3.67$, $p = .002$, $\eta_p^2 = .08$), no significant main effect for the method of answer derivation (Wilks’s $\lambda = .96$, $F(12, 514) = .79$, $p = .66$), and no significant multivariate interaction effect (Wilks’s $\lambda = .95$, $F(12, 514) = 1.09$, $p = .37$).

For the univariate analyses, Levene’s tests for all dependent variables were non-significant; CSE_{think} : $F(5, 262) = 1.08$, $p = .38$, CSE_{mem} : $F(5, 262) = 0.83$, $p = .53$, CSE_{TM} : $F(5, 262) = 0.07$, $p = 1.00$, perceived question difficulty: $F(5, 262) = 0.98$, $p = .43$, perception of the web as a knowledge partner: $F(5, 262) = 0.69$, $p = .64$, and anticipated future performance: $F(5, 262) = 2.07$, $p = .07$. Therefore, homogeneity of variances can be assumed. Regarding the univariate main effect for FoK, follow-up tests showed significant effects for CSE_{mem} ($F(1, 262) = 6.52$, $p = .01$, $\eta_p^2 = .02$), perceived question difficulty ($F(1, 262) = 8.57$, $p < .01$, $\eta_p^2 = .03$), and anticipated future performance ($F(1, 262) = 21.33$, $p < .001$, $\eta_p^2 = .08$). Consistent with H3, post-hoc tests showed that CSE_{mem} scores ($M = 3.77$,

⁵ Although determining high or low FoK condition assignment based on the average magnitude of high (or low) FoK questions is consistent with the theoretical premises of this study, it is possible that *magnitude* can be discrepant with the *volume* of unanswered high or low FoK questions (i.e., a low number of questions might have elicited a high magnitude of FoK, or vice-versa). Therefore, to maintain operational and conceptual consistency, analyses included only those participants whose magnitude and number scores were consistent (i.e., where, for instance, those in the low FoK condition had *both* more questions rated as low FoK and a greater average low FoK [versus high FoK] magnitude).

$SD = .88$) and anticipated future performance ($M = 72.00$, $SD = 16.94$) were higher under conditions of greater, versus lower FoK ($M = 3.27$, $SD = 1.02$; $M = 52.06$, $SD = 23.62$, respectively), and perceived question difficulty levels were lower for high ($M = 2.86$, $SD = .91$) versus low ($M = 3.40$, $SD = .95$) FoK levels. Thus, partial support was found for H3, whereas H4 and H5 were not supported.

Discussion

Experiencing greater FoK is related to greater CSE_{mem} , better anticipated future performance, and easier perceived question difficulty. However, searching the web (i.e., method of answer derivation) did not influence CSE or any of the other dependent variables, and the web was not perceived as a knowledge partner under any conditions. Across the results it is notable that only the memory dimension of CSE, but not thinking or transactive memory, received empirical support, and that assessment of one's task proficiency (via its low perceived difficulty and high future performance prediction for similar tasks) was more lenient when FoK was high. Regarding memory, the role of FoK belies the rational association between failing to answer questions and regarding one's memory as inadequate.

General Discussion

Though FoK was potentially responsible for elevated CSE in past studies, it had not been empirically validated. Two studies reported here demonstrate the importance of FoK in influencing metacognitive judgments and provide novel measures to capture it. Study 1 partially supports Ward's (2013a, 2021) theorized mechanism: When people experience a FoK, searching the web for information helps them confirm knowledge they already believe they possess, whereupon they conflate internal knowledge with external knowledge, and thereafter illusorily perceive that their information search skills (i.e., CSE_{TM} abilities), are better. Study 1 also suggests that merely conducting web searches may not enhance metacognitive self-evaluations. People may need to experience some FoK prior to conducting web searches before they will inflate their self-evaluations. This is consistent with Kahn and Martinez's (2020) observation that with regard to the relation between metacognitive judgments and digital memory tools "far more conditional processes may be going on" than were previously considered (p. 104).

The central role played by FoK is most apparent in Study 2, which found that experiencing a higher FoK results in

greater CSE_{mem} . Considering the results of both studies, searching the web seems to play a secondary, more facilitative role in inflating self-evaluations, as opposed to being the primary cause of inflated self-evaluations. Relatedly, Kahn and Martinez (2020) did not find evidence that the persistence versus ephemerality of information influenced overall CSE, suggesting that the presumed *external* availability of information (e.g., on the web) is less important than the presumed *internal* availability of information (e.g., as manifested via FoK), insofar as CSE is concerned. Moreover, in the current work self-assessments of one's own task proficiency (i.e., perceived question difficulty and anticipated future performance) were also more optimistic when FoK was high, signaling an overall sense of optimism from its elevation.

Another important finding is that the three subdimensions of CSE function differently, although previous research has not always considered them separately (e.g., Hamilton & Yao, 2018; Kahn & Martinez, 2020). Results show that the memory and transactive memory subdimensions (CSE_{mem} and CSE_{TM}) are more sensitive to the influences of FoK and/or conducting web searches than the thinking subdimension (CSE_{think}). This is partially consistent with the central argument that internal and external knowledge may be conflated, which fundamentally pertains to memory (CSE_{mem}) more than to thinking (CSE_{think}). Memory seems more clearly implicated in the act of recalling trivia questions and, indeed, may have been more fully primed by the nature of the trivia task. Regarding CSE_{TM} , results from Study 1 suggest that the knowledge of where to find answers is elevated upon learning new information by searching the web. This presents further evidence for arguments made by other researchers that the Internet functions as a transactive memory partner – a place for storing (or cognitively offloading) memories of things like facts, concepts, and general knowledge as well as a source of information when those memories need to be retrieved (Sparrow et al. 2011; Stone & Storm, 2021). By contrast, thinking ability (CSE_{think}) was unaffected in the present studies by FoK or the methods (or lack) of information provision. In these studies, these features were not sufficient to alter one's self-perceptions on this more global level.

The lack of a direct effect for method of answer derivation across both studies differs from previous research showing that searching the web leads directly to greater CSE than not searching the web (Fisher et al., 2015; Hamilton & Yao, 2018; Ward, 2013a, 2021). There are several possibilities for this discrepancy. In previous studies (e.g., Ward, 2013a, 2021), participants saw trivia questions once, and at the same time searched the web for answers (or not). In the present studies, participants saw the trivia questions multiple times, initially so that they could assess the

questions, and subsequently to measure FoK and/or to search the web for answers (or not, or were provided answers). Moreover, in the present studies participants were instructed to focus on questions to which they could *not* provide answers, both by rating their FoK and by performing searches solely on such questions.

Due to these procedural features, the attention drawn to participants' lack of answers/knowledge may have served to make them especially aware of their own ignorance, which in turn may have served to stymie the potential conflation between internal and external knowledge – thus producing a potential limitation of the findings. As Fisher and Oppenheimer (2021b) established, ambiguity as to who deserves credit for information serves to elevate knowledge misattribution in ways that enhance metacognitive self-assessments. When such credit ambiguity is removed – as was the case in the present studies, which highlighted people's *lack* of knowledge – people better calibrate their understanding of who deserves credit, and misattribution is diminished. Other procedural features may have similarly undermined the conflation of internal and external information. For example, the faster people search the web for trivia answers, the better they predict they will score on a future test on what they had searched for (Stone & Storm, 2021), and people are more likely to misattribute information from the web to themselves if the information was obtained via a Google search rather than through a link to a Wikipedia page (experiment 8, Ward, 2021). In such cases, cognitive processing fluency (see Schwarz, 2004) is implicated in heightened opportunities for internal and external knowledge conflation (see Stone & Storm, 2021). In the present research, however, fluency was potentially disrupted by directing attention to unanswered questions and by temporally separating self-generated answers from web-based information sources.

A limitation concerning Study 2 is the possibility that the relationship between FoK and CSE is plausibly linked to underlying factors such as education level or overall (i.e., not specific to CSE) confidence. In other words, there could be a self-selection effect that determined whether people were classified as high or low FoK, whereby certain people may be both more prone to greater FoK *and* also be higher in CSE. Put differently, CSE may be influenced by FoK or by other extraneous underlying factors. Although the same critique does not apply to Study 1's results (where all assignment was random), it is nonetheless possible that overall confidence may have influenced participants' willingness to guess the trivia answers, detrimentally affecting the extent to which FoK was sensitive to the randomized manipulation of question difficulty. Future work should attempt to manipulate FoK more directly or consider the degree to

which particular people may be more or less prone to metacognitive inflation effects. In the latter domain, it's interesting to note that any self-selection effects in Study 2 should – in a strict sense – apply only to CSE_{mem}, but not to CSE_{think} (i.e., people self-selected into the high or low FoK conditions due to what information they could recall), suggesting that recollection, but not self-assessments regarding overall intelligence, might be responsible for any cognitive misjudgments regarding CSE as a whole.

Future research can also advance the idea that the web acts as a transactive memory partner by considering the degree to which people readily accept information from the web. According to Clark and Chalmers (1998), people use the environment as part of their cognitions, by manipulating the environment (e.g., recording thoughts in a notebook, rearranging tiles in Scrabble). In this way, Clark and Chalmers (1998) argued, one's extended mind goes beyond one's corporeal body to involve environmental components. One important criterion for the extended mind hypothesis is that people will unthinkingly accept information from any external entity that they consider part of their extended mind. In Clark and Chalmers' (1998) thought experiment regarding the fictitious notebook user, Otto, "upon retrieving information from the notebook he *automatically* endorses it" (p. 15, italics added). The present studies did not collect data on the extent to which people automatically accepted the information they found via their Google searches. As such, these studies cannot rule out the possibility that participants doubted the veracity of the trivia answers they found on Google (although this seems unlikely, given that the answers were based on facts and not opinion). Yet, future research can study information that is less clear-cut than the facts used in this study to test the boundary conditions of the metaphor that the web is a transactive memory partner.

Overall, the present studies provide compelling evidence that FoK is an important psychological mechanism underlying people's inflated self-esteem in the context of a digital media environment where information is abundantly and easily available. Evidence of this metacognitive effect is particularly intriguing since it is also highly paradoxical: under precisely the circumstances when people should recognize their memory has failed them (i.e., they cannot recall an answer), they assess their memory to be especially strong. The fulcrum of this relationship, it appears, is that people must also experience a suitable FoK, such that they can convince themselves that their memory failure is in fact deceptive or fleeting. Future studies are imperative to sort out the precise nature of such metacognitive judgments in the context of an information environment that appears to make them more common and compelling.

Electronic Supplementary Materials

The following electronic supplementary material is available with this article at <https://doi.org/10.1027/1864-1105/a000426>

ESM 1. Appendix A; Appendix B

ESM 2. Pretest details.

References

- Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis*, 58(1), 7–19. <https://doi.org/10.1093/analys/58.1.7>
- Efklides, A. (2006). Metacognition and affect: What can metacognitive experiences tell us about the learning process? *Educational Research Review*, 1(1), 3–14. <https://doi.org/10.1016/j.edurev.2005.11.001>
- Fischhoff, B., & Beyth, R. (1975). I knew it would happen: Remembered probabilities of once-future things. *Organizational Behavior and Human Performance*, 13(1), 1–16. [https://doi.org/10.1016/0030-5073\(75\)90002-1](https://doi.org/10.1016/0030-5073(75)90002-1)
- Fisher, M., Goddu, M. K., & Keil, F. C. (2015). Searching for explanations: How the Internet inflates estimates of internal knowledge. *Journal of Experimental Psychology: General*, 144(3), 674–687. <https://doi.org/10.1037/xge0000070>
- Fisher, M., & Oppenheimer, D. M. (2021a). Harder than you think: How outside assistance leads to overconfidence. *Psychological Science*, 32(4), 598–610. <https://doi.org/10.1177/0956797620975779>
- Fisher, M., & Oppenheimer, D. M. (2021b). Who knows what? Knowledge misattribution in the division of cognitive labor. *Journal of Experimental Psychology: Applied*, 27(2), 292–306. <https://doi.org/10.1037/xap0000310>
- Flanagin, A. J., & Lew, Z. (2023). Individual inferences in web-based information environments: How cognitive processing fluency, information access, active search behaviors, and task competency affect metacognitive and task judgments. *Media Psychology*, 26(1), 17–35. <https://doi.org/10.1080/15213269.2022.2085116>
- Hamilton, K. A., & Yao, M. Z. (2018). Blurring boundaries: Effects of device features on metacognitive evaluations. *Computers in Human Behavior*, 89, 213–220. <https://doi.org/10.1016/j.chb.2018.07.044>
- Hanczakowski, M., Zawadzka, K., & Cockcroft-McKay, C. (2014). Feeling of knowing and restudy choices. *Psychonomic Bulletin & Review*, 21, 1617–1622. <https://doi.org/10.3758/s13423-014-0619-0>
- Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Press.
- Heersmink, R. (2016). The Internet, cognitive enhancement, and the values of cognition. *Minds and Machines*, 26, 389–407. <https://doi.org/10.1007/s11023-016-9404-3>
- Kahn, A. S., & Martinez, T. M. (2020). Text and you might miss it? Snap and you might remember? Exploring “Google effects on memory” and cognitive self-esteem in the context of Snapchat and text messaging. *Computers in Human Behavior*, 104, Article 106166. <https://doi.org/10.1016/j.chb.2019.106166>
- Marsh, E. J., & Rajaram, S. (2019). The digital expansion of the mind: Implications of Internet usage for memory and cognition. *Journal of Applied Research in Memory and Cognition*, 8(1), 1–14. <https://doi.org/10.1016/j.jarmac.2018.11.001>
- McLuhan, M. (1994). *Understanding media: The extensions of man*. MIT Press.
- Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 26, pp. 125–173). Academic Press.
- Pohl, R. F., Bender, M., & Lachmann, G. (2002). Hindsight bias around the world. *Experimental Psychology*, 49(4), 270–282. <https://doi.org/10.1026/1618-3169.49.4.270>
- Roese, N. J., & Vohs, K. D. (2012). Hindsight bias. *Perspectives on Psychological Science*, 7(5), 411–426. <https://doi.org/10.1177/1745691612454303>
- Schwarz, N. (2004). Metacognitive experiences in consumer judgment and decision making. *Journal of Consumer Psychology*, 14(4), 332–348. https://doi.org/10.1207/s15327663jcp1404_2
- Singer, M., & Tiede, H. L. (2008). Feeling of knowing and duration of unsuccessful memory search. *Memory & Cognition*, 36(3), 588–597. <https://doi.org/10.3758/MC.36.3.588>
- Sloman, S. A., & Rabb, N. (2016). Your understanding is my understanding: Evidence for a community of knowledge. *Psychological Science*, 27(11), 1451–1460. <https://doi.org/10.1177/0956797616662271>
- Sparrow, B., Liu, J., & Wegner, D. M. (2011). Google effects on memory: Cognitive consequences of having information at our fingertips. *Science*, 333(6043), 776–778. <https://doi.org/10.1126/science.1207745>
- Stone, S. M., & Storm, B. C. (2021). Search fluency as a misleading measure of memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 47(1), 53–64. <https://doi.org/10.1037/xlm0000806>
- Storm, B. C., Stone, S. M., & Benjamin, A. S. (2017). Using the Internet to access information inflates future use of the Internet to access other information. *Memory*, 25(6), 717–723. <https://doi.org/10.1080/09658211.2016.1210171>
- Ward, A. F. (2013a). *One with the Cloud: Why people mistake the Internet’s knowledge for their own*. Harvard University (Unpublished doctoral dissertation).
- Ward, A. F. (2013b). Supernormal: How the Internet is changing our memories and our minds. *Psychological Inquiry*, 24(4), 341–348. <https://doi.org/10.1080/1047840X.2013.850148>
- Ward, A. F. (2021). People mistake the Internet’s knowledge for their own. *Proceedings of the National Academy of Sciences*, 118(43), Article e2105061118. <https://doi.org/10.1073/pnas.2105061118>
- Wegner, D. M. (1987). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185–208). Springer.

History

Received July 27, 2023

Revision received January 17, 2024

Accepted January 17, 2024

Published online April 8, 2024

Open Data

Materials from this study will be shared upon reasonable request made to the corresponding author.

ORCID

Zijian Lew

 <https://orcid.org/0000-0003-1769-7898>

Zijian Lew

Wee Kim Wee School of Communication and Information
Nanyang Technological University
50 Nanyang Avenue
Singapore 639798
zlew@ntu.edu.sg



Zijian Lew (PhD) is an Assistant Professor at the Wee Kim Wee School of Communication and Information, Nanyang Technological University, Singapore. He studies self-effects and social influence in various digital contexts.



Andrew J. Flanagin (PhD) is a Professor in the Department of Communication at the University of California, Santa Barbara, where he is a former Director of the Center for Information Technology and Society. His work broadly considers processes of social influence in digitally-mediated environments, with emphases on the use of social media for information sharing and assessment; people's perceptions of the credibility of information gathered and presented online; processes of collective organizing; and the metacognitive effects of information-saturated environments.

Appendix A

Study 1 and Study 2, Confirmatory Factor Analysis for Cognitive Self-Esteem

A confirmatory factor analysis (CFA) using MPlus was performed to test the factor structures of and correlations between the three theorized dimensions of cognitive self-esteem (CSE): CSE_{think}, CSE_{mem}, and CSE_{TM}. The 3-factor model tested CSE_{think}, CSE_{mem}, and CSE_{TM} as three separate factors. The 2-factor model tested CSE_{think+mem} (i.e., CSE_{think} and CSE_{mem} combined) and CSE_{TM} as two factors, due to the stronger bivariate correlation between CSE_{think} and CSE_{mem} than with CSE_{TM}. The 1-factor model tested all three CSE subdimensions as a unidimensional factor.

Results showed that the 3-factor model had the best fit statistics across both Study 1 and Study 2 (Table A1). Therefore, hypothesis testing relied on the 3-factor solution. Factor loadings are displayed in Table A2 and correlations among the latent factors are displayed in Table A3.

Table A1

Fit Indices in CFAs for Cognitive Self-Esteem

Model	χ^2	<i>df</i>	<i>p</i> -value	RMSEA	90% CI	CFI	SRMR
Study 1							
1-factor	578.60	77	< .001	.162	[.150, .174]	.699	.100
2-factor	483.24	76	< .001	.147	[.134, .159]	.755	.092
3-factor	240.86	74	< .001	.095	[.082, .109]	.900	.066
Study 2							
1-factor	735.55	77	< .001	.179	[.167, .191]	.691	.120
2-factor	441.17	76	< .001	.134	[.122, .146]	.828	.097
3-factor	153.30	74	< .001	.063	[.049, .077]	.963	.055

Note. χ^2 = chi-square test of model fit; RMSEA = root-mean square error of approximation; CFI

= comparative fit index; SRMR = standardized root mean square residual.

Table A2*Factor Loadings for the 3-Factor Solution*

Latent Factor (Dependent Variable) / Item	Factor Loading, Study 1	Factor Loading, Study 2
CSE_{think}		
1. I am smart.	.647	.742
2. I am smarter than the average person.	.616	.657
3. My mind is one of my best qualities.	.769	.789
4. I am good at thinking.	.817	.773
5. I feel good about my ability to think through problems.	.771	.777
6. I am capable of solving most problems without outside help.	.681	.673
CSE_{mem}		
7. I am proud of my memory.	.909	.887
8. I feel good about my ability to remember things.	.830	.898
9. I have a better memory than most people.	.789	.866
10. I have a good memory for recalling trivial information.	.683	.798
CSE_{TM}		
11. I know where to look to answer questions I don't know myself.	.627	.810
12. When I don't know the answer to a question right away, I know where to find it.	.699	.864
13. I know which people to ask when I don't know the answer to a question.	.460	.486
14. I have a knack for tracking down information.	.680	.670

Table A3*Correlations Between Latent Factors in the 3-Factor CFAs*

Item	1	2
Study 1		
1. CSE _{think}	-	
2. CSE _{mem}	.66	-
3. CSE _{TM}	.66	.32
Study 2		
1. CSE _{think}	-	
2. CSE _{mem}	.72	-
3. CSE _{TM}	.47	.22

Appendix B

Study 2, Confirmatory Factor Analysis

A confirmatory factor analysis (CFA) using MPlus was performed to test the factor structures of and correlations between the dependent variables in Study 2: CSE_{think} , CSE_{mem} , CSE_{TM} , perceived question difficulty, and perception of the web as a knowledge partner. The dependent variable anticipated future performance was not included in the factor analysis since it was composed of only a single item.

The CFA results showed decent fit statistics: $\chi^2(199) = 467.97, p < .001$; RMSEA (root-mean square error of approximation) = .071, 90 % CI = [.063, .079]; CFI (comparative fit index) = .911; SRMR (standardized root mean square residual) = .070. Factor loadings were good for most measures (Table B1), and correlations among the latent factors were sufficiently low (Table B2). These results suggest that the dependent measures have adequate discriminant validity.

Table B1

Factor Loadings in a CFA, Study 2

Latent Factor (Dependent Variable) / Item	Factor Loading
CSE_{think}	
1. I am smart.	.744
2. I am smarter than the average person.	.654
3. My mind is one of my best qualities.	.791
4. I am good at thinking.	.773
5. I feel good about my ability to think through problems.	.777
6. I am capable of solving most problems without outside help.	.671
CSE_{mem}	
7. I am proud of my memory.	.884
8. I feel good about my ability to remember things.	.898
9. I have a better memory than most people.	.865
10. I have a good memory for recalling trivial information.	.803

CSE_{TM}

11. I know where to look to answer questions I don't know myself.	.811
12. When I don't know the answer to a question right away, I know where to find it.	.863
13. I know which people to ask when I don't know the answer to a question.	.486
14. I have a knack for tracking down information.	.671

Perceived question difficulty

15. The trivia questions were difficult.	.868
16. I found myself challenged by the trivia questions.	.822
17. I had a hard time answering the trivia questions.	.855

Perception of the web as a knowledge partner

18. If I need to know something it doesn't matter if the information is online or in my own memory.	.656
19. Online information is like having a knowledgeable partner with me at all times.	.398
20. Having information available online is like knowing something myself.	.701
21. I don't need to remember things that are available online.	.640
22. If I can't access the Internet I feel like I know less.	.472

Table B2*Correlations Between Latent Factors in a CFA, Study 2*

Item	1	2	3	4
1. CSE _{think}	-			
2. CSE _{mem}	.72	-		
3. CSE _{TM}	.47	.22	-	
4. Perceived question difficulty	-.17	-.38	-.08	-
5. Perception of web as knowledge partner	-.10	-.11	.02	.19

<https://doi.org/10.1027/1864-1105/a000426>

Pretest Details

Procedure

To derive questions of high, medium, and low difficulty, a pretest was conducted in the United States with a separate sample of subjects from the main studies, recruited through Amazon's Mechanical Turk ($N = 715$). Participants were randomly presented with 5 from among 97 trivia questions originally used in Ward (2013), one by one, each on a separate page via an online interface. Participants were instructed to not use a search engine during this task.

For each question participants either provided an answer or indicated "I can't think of the answer right now," after which they rated each trivia question's difficulty by responses to 6 items, each on a 5-point Likert-type scale (ranging from 1 [*strongly disagree*] to 5 [*strongly agree*]). Items used to assess perceived question difficulty were: "This is a hard question to answer," "Most people would be able to answer this question easily" (reverse coded), "This is a very challenging question," "This question is easy" (reverse coded), "Most people would know the answer to this question" (reverse coded), and "This question would stump most people."

Sample

Participants' ages ranged from 18 to 75 years old ($M = 28.8$, $SD = 11.7$). When participants were asked for their biological sex, 54.5% indicated male, 44.5% indicated female, 0.6% indicated "other" or "prefer not to say," and 0.4% did not answer the question. In terms of ethnicity, among participants 76.4% were White, 7.6% were Asian, 5.0% were Black, 4.9% were Hispanic/Latino, 0.3% were American Indian or Alaska Native, 0.3% were Native Hawaiian or Pacific Islander, 4.6% had mixed ethnicities, 0.8% selected "other." About 0.3% of participants did not answer this question.

<https://doi.org/10.1027/1864-1105/a000426>

Results

The perceived difficulty scores were used to rank the difficulty of the 97 initial trivia questions and to determine which questions were selected for the two main studies. “Hard” trivia questions were those ranked as most difficult in the pretest, with the omission of 3 questions that were either readily guessable or might rely on calculations rather than memory (e.g., “How many squares are there on a chess board—including squares of all possible sizes?”). Similarly, “easy” trivia questions were those ranked as the least difficult in the pretest, with the omission of a small number of questions that were deemed so easy as to be unlikely to elicit any feeling of knowing, which requires at least a modest degree of uncertainty (e.g., “How many seconds are in a minute?”). “Medium” difficulty trivia questions were selected from the middle range of the ranked list, though a few questions were omitted due to factors such as comprehension concerns (e.g., concern that not all respondents would know the meaning of “precursor” in the following question: “In what country was the precursor to Pizza invented?”). Table 1 lists the hard, medium, and easy difficulty questions used in Study 1 and Study 2, along with each question’s mean perceived difficulty score (and the standard deviation).

Table E1*Pretested Means and Standard Deviations of Trivia Questions*

Question	<i>M</i>	<i>SD</i>	Study 1	Study 2
<i>Hard Difficulty Questions</i>				
1. What is the molecular formula for caffeine?	4.50	0.72	✓	
2. What is the national flower of Australia?	4.34	0.48	✓	
3. Of what country is Ulaanbaatar the capital?	4.33	0.71	✓	
4. In what year did the Spanish Civil War end?	4.29	0.75	✓	
5. Which country declared independence on February 18th, 2008?	4.24	0.61	✓	
6. What is the name of the first dog to orbit the earth?	4.06	0.86	✓	
7. In what language does "obrigado" mean "thank you"?	4.01	0.81	✓	
8. What brothers invented the hot-air balloon?	3.82	1.01	✓	
9. Which US President served the shortest term in office?	3.71	0.86	✓	
10. How much does one liter of water weigh, in kilograms?	3.69	0.82	✓	
<i>Medium Difficulty Questions</i>				
1. Which state is called the volunteer state?	3.29	1.01		✓
2. What male athlete has won the most Olympic medals?	3.28	0.94		✓
3. What is the capital of Austria?	3.22	1.04		✓
4. In what country is Mt. Vesuvius located?	3.18	0.88		✓
5. What nationality was Marco Polo?	3.05	1.05	✓	
6. What is the most spoken language on Earth?	3.04	1.01	✓	
7. If you were born on May 22nd, what is your Zodiac symbol?	3.03	0.81	✓	
8. What is the capital of Peru?	2.96	0.95	✓	
9. Who is the current CEO of Apple, Inc?	2.93	0.90	✓	✓
10. What is the name of the longest river in the world?	2.87	0.72	✓	✓
11. What is the most abundant element in the earth's atmosphere?	2.83	0.98	✓	
12. What is the smallest state in the USA (in terms of land area)?	2.81	1.07	✓	✓
13. What currency is used in Germany?	2.79	0.92	✓	✓
14. Who is the Greek god of the sea?	2.74	1.15	✓	✓
15. What is the main system of measurements used in the United States?	2.71	0.95		✓

<https://doi.org/10.1027/1864-1105/a000426>

16. Who directed the movie Titanic?	2.69	0.96	✓
17. Who painted the Sistine Chapel?	2.65	1.08	✓
18. What animal represents the astrological sign of Cancer?	2.64	1.01	✓
19. What animal's diet is made up almost entirely of eucalyptus leaves?	2.63	1.06	✓
20. What is the name of the highest mountain in the world?	2.63	0.90	✓

Easy Difficulty Questions

1. Who was the first man on the moon?	1.99	0.64	✓
2. Gingivitis is an infection of what part of the body?	1.97	0.87	✓
3. What car company produces the Mustang?	1.96	0.94	✓
4. During games, how many basketball players from one team are on the court at any given time?	1.94	0.70	✓
5. What color comes from mixing together yellow and red?	1.92	0.77	✓
6. In which city is Hollywood located?	1.87	0.65	✓
7. Who is credited with writing Romeo and Juliet?	1.74	0.86	✓
8. In what state is the Empire State Building located?	1.69	0.63	✓
9. What does the "F" stand for in the law enforcement acronym FBI?	1.67	0.71	✓
10. What computer brand shares its name with a fruit?	1.37	0.64	✓

Note. A tick mark indicates that the trivia question was used in the respective study.