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Individual Inferences in Web-Based Information Environments: How Cognitive Processing Fluency, Information Access, Active Search Behaviors, and Task Competency Affect Metacognitive and Task Judgments

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ABSTRACT

Online information repositories increasingly serve as memory aids in people's lives. Access to such information stores, however, can result in false perceived equivalencies between web-based information and personal knowledge, which can in turn influence judgments of oneself, of information search tasks, and of the Internet itself. *Cognitive processing fluency*, *access to reliable web-based information*, and *actively searching for information* are shown in a series of experiments to be associated with judgments related to metacognition and task performance. In the context of online information repositories accessed via web search activities, people are shown to (a) overemphasize the degree to which they find the web to be a ready source of relevant information, (b) overestimate their future task performance and the ease of tasks, and (c) inflate their own perceived cognitive and memory abilities. Results also show that those who are least competent in task completion overestimate their relative performance, whereas the most competent underestimate theirs, and that the availability of web-based information can inflate people's estimated performance, particularly among the more competent. Collectively, three interrelated studies add considerable new insight regarding the impacts of near-ubiquitous access to contemporary information-saturated environments.

Near-ubiquitous digital devices are increasingly used as memory aids in people's daily lives. Rather than relying on their mental faculties to store information, people now routinely retrieve information from the web, reducing the amount of cognitive load associated with information storage and retrieval (Marsh & Rajaram, 2019; Pieschl, 2021; Sparrow et al., 2011; Storm & Stone, 2015). Reliance on Internet-enabled tools for memory work thus constitutes a transactive memory partnership, where people allocate the responsibility of storing (i.e., remembering) information across a variety of topics to those with comparative expertise in each subject (Wegner, 1987), thereby opting not to remember what they can easily retrieve via efficient search engines like Google.

Ubiquitous access to the web has also been shown to influence the way people think about their own cognitive processes (i.e., metacognitive judgments; Nelson & Narens, 1990) such as cognitive self-esteem (CSE), a subjective self-rated measure of cognitive ability comprised of three dimensions: confidence in one's own thinking ability (CSE_{think}), memory ability (CSE_{mem}), and ability to search for information in a transactive memory partnership (CSE_{TM}; Ward, 2013a). People have been shown to rate their CSE more highly after searching the web for information than when not searching the web

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(Hamilton & Yao, 2018; Ward, 2013a). This illusion seems to be transferrable across knowledge domains: For example, people who answered questions in one domain (e.g., lunar phases) by searching the web for information (versus searching only their own memories) believed they had better ability to answer questions in a separate domain as well (e.g., American history; Fisher et al., 2015).

Three studies are described that extend research on knowledge source misattributions in the context of access to web-based information, where external (e.g., web-based) information sources are confounded with internal (i.e., inside people's own heads) knowledge (see e.g., Fisher et al., 2015; Fisher & Oppenheimer, 2021; Stone & Storm, 2021; Ward, 2021). Study 1 considers the role of *cognitive processing fluency*, or the subjective ease of information processing, and demonstrates qualified support for the notion that greater fluency prompts (a) higher metacognitive self-judgments (i.e., CSE), (b) perceptions of lower task difficulty, and (c) appraisals of improved future task performance. Study 2 provides additional evidence for elevated perceptions of one's own cognitive abilities under circumstances where *access* to web-based information may be misattributed to one's self, compared to circumstances where access is absent. Critically, results also suggest that proactively *searching* for information is an important factor in the conflation of external and internal information sources. Study 3 extends these findings by examining whether people's metacognitive, task, and information judgments are linked also to their actual *task performance*, and finds that, among other things, access to web-based information among the most competent negates a tendency to underestimate one's own performance. Collectively, findings from these studies add considerable new understanding to research on knowledge source misattribution, or the blurring of boundaries between external web-based information and people's internal knowledge (Ward, 2021), in the context of near-ubiquitous access to contemporary information-saturated environments.

Cognitive Processing Fluency

Cognitive processing fluency describes the subjective ease or difficulty with which people process information (Schwarz, 2004). Fluency is generated via a large diversity of subjective mechanisms, including memory-based, linguistic, visual, conceptual, perceptual, and embodied cues, and it influences judgments across a correspondingly wide array of social and personal dimensions (see Alter & Oppenheimer, 2009 for an overview). Indeed, fluency has been conceptualized as a “ubiquitous metacognitive cue in reasoning and social judgment” since it can be instantiated in a host of ways, with remarkably similar outcomes (Alter & Oppenheimer, 2009, p. 219).

Feelings of dis/fluency can lead people to make various inferences about themselves, about information being processed, or about the environment (Schwarz, 2004; Schwarz et al., 2007). In the context of seeking information (e.g., a trivia question task) online, some judgments made after fluent processing may involve outward attributions. For instance, participants who have a fluent search experience could think that the task is easier than participants who have a disfluent search experience. Additionally, a fluent web search experience could make people hold more positive Internet-specific epistemic beliefs overall, which is a measure of the extent to which people believe that information on the web is correct (Bråten et al., 2005; Kammerer & Gerjets, 2012), or they may perceive that, metaphorically, the web is a better knowledge (i.e., transactive memory) partner. However, people can also make judgments in the context of fluencies that involve self-attributions – they may believe they will have superior performance on a future task or might think more positively of their own subjective cognitive abilities like CSE.

Indeed, due to greater feelings of cognitive processing fluency, people overrate their own cognitive abilities after searching the web for information (Ward, 2021). For example, Hamilton and Yao (2018) tasked participants to search the web for answers to trivia questions using either their personal digital devices (i.e., mobile phone or laptop) or the lab's digital devices. Those who searched the web using their personal devices rated themselves more highly on CSE than those who used the lab's devices, presumably because familiarity gave people a more fluent web search experience. They in turn experienced a “know it all along” effect, a retrospective judgment of one's memory to accommodate

new information (Fischhoff & Beyth, 1975; also known as hindsight bias). In this case, participants attributed the fluency to their own supposedly superior cognitive abilities, while discounting the aid provided by the web.

Conceptualizing cognitive processing fluency as a function of information search speed or automaticity has yielded similar results. 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, in a study assessing the concordance between web search and the cognitive operations used in internal memory, participants were 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). This knowledge source misattribution can be seen as a function of the relatively higher fluency of Googling, and Ward (2021) argued that “seamless connection to online information does not just blur the boundaries between internal and external knowledge – at times, it may erase these boundaries entirely, leading people to believe that information found online was in fact found within their own skulls” (pp. 5–7).

Indeed, experience-based cues such as fluency – versus information-based cues such as pre-conceived beliefs – have long been known to influence people’s metacognitive assessments such as judgments of learning (Kelley & Jacoby, 1996; Koriat, 1997). Whereas information-based judgments are grounded in domain-specific beliefs held in long-term memory, experience-based judgments are derived from the experience of information processing itself. Thus, “cues such as the fluency with which information is encoded or retrieved . . . relate to the . . . feedback that one obtains online from one’s own processing and performance” (Koriat et al., 2008, p. 119). In this manner, experience-based judgments arise from a subjective feeling that is implicit, largely unconscious, and a by-product of the ordinary learning process. So, “if users experience the process of searching for information on the Internet as positive, for example, by experiencing ease, speed, fluency, and immediate availability of information, users might intuit that they would be able to answer knowledge question[s]” and “information about and search experiences with the Internet might bias users toward overestimating their information problem-solving” (Pieschl, 2021, p. 112).

Accordingly, Study 1 tests the role of cognitive processing fluency in the context of web search. More specifically, in response to questions regarding factual information, in the form of trivia questions, individuals who immediately search the web for answers (“web search”) should have a more fluent information-seeking experience than those who carefully consider an answer before searching the web (“think then search”), who should in turn experience greater cognitive processing fluency than those who both consider and explicitly provide an answer prior to searching (“answer then search”). H1 formalizes these relationships:

H1_{a-e}: Methods of answer derivation that evoke greater information search fluency levels will evoke progressively greater (a) cognitive self-esteem, (b) Internet-specific epistemic beliefs, (c) sense of the web as a knowledge partner, (d) anticipated future performance, and progressively lower (e) perceived question difficulty.

Study 1

Sample

Participants in the US were recruited via Amazon’s Mechanical Turk. At the study’s outset participants were asked to describe their surroundings and any other activities they were involved in while participating and in the questionnaire they also responded to 2 simple attention checks. Those who were clearly significantly distracted (e.g., “talking to friends” or “watching a video” while performing

the task), or who failed the attention check items, were eliminated from the study, as were those who reported after the study that they had violated the study's instructions. This resulted in 178 valid participants¹ ($N = 178$).

Procedure

Participants were instructed that they would be answering some trivia questions, which would vary in difficulty and, consequently, they would likely know some but not all of the answers (see Electronic Supplementary Material 1, Part I, for notes on the use of trivia questions for hypothesis testing). They were also told that payment was not contingent on the number or correctness of their responses. Participants were then randomly placed into one of three conditions: search the web for answers ("web search"), think of an answer and then search the web ("think then search"), or provide an answer and then search the web to verify/get answers ("answer then search"). In each condition participants were presented with 15 medium-difficulty trivia questions (which were randomly counterbalanced in presentation order), one at a time (Electronic Supplementary Material 1, Part II, describes the derivation of these questions).

In the *web search* condition ($n = 61$) participants were instructed that speed was of the essence and that they should therefore immediately use the search engine of their choice to seek and provide answers from the web for each question, regardless whether they already knew or thought they may know the answer. In the *think then search* condition ($n = 58$) participants were instructed that searching their memory for question answers was paramount and that they should "take some time to think of your answer." After each question was displayed, participants were reminded to "take a moment to think about your answer" and, after a 6-second imposed delay, they were instructed to use the search engine of their choice to check or verify this answer and enter it in the space provided. In the *answer then search* condition ($n = 59$) participants were instructed to provide answers to all trivia questions, one at a time, including their "best guess" if necessary; they also had the option to indicate "I really don't know the answer." In this condition participants were instructed *not* to use a search engine to look up answers to the questions at this juncture, and to minimize the temptation to do so, participants were told that at the completion of the task answers would be revealed to them. In actuality, after answering (or attempting to answer) all of the questions, subjects in this condition were subsequently instructed that although they were previously asked not to use a search engine, they should now use the search engine of their choice to answer each question in turn, which they then input one by one. In all conditions, participants completed a posttest questionnaire following task completion. A manipulation check was conducted to assess whether the experimental conditions varied in perceived cognitive fluency as proposed and results showed the anticipated differences between groups (see Electronic Supplementary Material 1, Part III).

Measures

The cognitive self-esteem measure (Ward, 2013a) had three dimensions. The *thinking* dimension (CSE_{think}) comprised 6 items, such as "I am smarter than the average person" ($M = 3.89$, $SD = .58$, Cronbach's $\alpha = .84$). The *memory* dimension (CSE_{mem}) consisted of 4 items, such as "I feel good about my ability to remember things" ($M = 3.50$, $SD = .84$, Cronbach's $\alpha = .90$). The *transactive memory* dimension (CSE_{TM}) was made up of 4 items, such as "I know where to look to answer questions I don't know myself" ($M = 4.25$, $SD = .48$, Cronbach's $\alpha = .70$). Responses ranged from 1 (*strongly disagree*) to 5 (*strongly agree*).

Internet-specific epistemic beliefs was based on a scale originally proposed by Bråten et al. (2005) and later modified by Kammerer and Gerjets (2012). It was pre-tested and validated with a sample of users separate from the current study. This measure included items such as "The Internet can provide most of the information I need to inform myself about any given topic" ($M = 4.06$, $SD = .48$, Cronbach's $\alpha = .82$). *Perceived question difficulty* was an original measure that asked 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;” $M = 2.65$, $SD = 1.00$, Cronbach’s $\alpha = .90$). *Perception of the web as a knowledge partner* was an original measure 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” ($M = 3.19$, $SD = .69$, Cronbach’s $\alpha = .64$). These measures were assessed on Likert-style questions ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Anticipated *future performance* ($M = 69.47$, $SD = 21.54$) 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. A confirmatory factor analysis of these measures, showing that the outcome variables are suitably distinct from one another, is included in the Electronic Supplementary Material 2.

Results

Hypotheses 1_{a-d} were analyzed via a MANOVA (with the method of answer derivation as the independent factor: web search, think then search, and answer then search) with CSE_{think} , CSE_{mem} , CSE_{TM} , Internet-specific epistemic beliefs, perceived question difficulty, web as knowledge partner, and anticipated future performance as the dependent variables. Detailed multivariate, univariate, and post-hoc results are shown in Table 1. Results showed a significant multivariate effect of method of answer derivation on the dependent variables and follow-up tests showed significant effects for CSE_{think} , Internet-specific epistemic beliefs, perceived question difficulty, and anticipated future performance, but not for the other outcome variables.

Consistent with H1_b, post-hoc tests showed that Internet-specific epistemic beliefs were higher in the “think then search” condition than in the “answer then search” condition (though there was no significant difference compared to the “web search” condition). CSE_{think} (H1_a) and anticipated future performance (H1_d) were greater for the “web search” and “think then search” conditions (which did not differ from one another), versus the “answer then search” condition. Perceived question difficulty levels (H1_c) were lower for “web search” and “think then search” conditions (which did not differ from each other), versus the “answer then search” condition. Thus, partial support was found for H1_a, H1_b, H1_d, and H1_e; H1_c was not supported.

Study 1 Discussion

Results show qualified support that greater cognitive fluency influences a variety of judgments. Contemplating answers,² before subsequently searching for them, prompts greater epistemic belief in the Internet, as compared to first providing (or attempting to provide) answers and then subsequently using a search engine to verify/find them. Reflecting on one’s answers, without explicitly or formally committing to them, bolsters the feeling that people find the web to be a ready source of relevant information. In this manner, reflecting on one’s knowledge without committing to it might serve to solidify knowledge source misattribution.

Similarly, self-perceived cognitive ability (CSE_{think}) and other judgments related to task performance (perceived question difficulty and one’s estimated future performance on a similar task) varied (i.e., lower difficulty; greater CSE_{think} and performance) when searching for answers swiftly or after contemplation, relative to committing to answers first and subsequently searching the web. This indicates that greater fluency might beget greater confidence in one’s own metacognitive judgments and enhanced task confidence. Overall, greater fluency when searching for information appears to some degree to enhance judgments of the self and the web compared to disfluency caused by explicit commitment to an answer.

Although Study 1 demonstrates that greater fluency affects the judgments that people make about their own cognitive abilities, an information search task, and the Internet, results are also somewhat inconsistent with fluency explanations in that web search (the most fluent among the conditions) did

Table 1. Results for Study 1.

Multivariate and Univariate Results				
	<i>F</i>	<i>df1, df2</i>	<i>p</i>	η^2
Multivariate				
Wilks's lambda = .77	3.23	14, 338	< .001***	.12
Univariate				
CSE _{think}	4.44	2, 175	.01**	.05
CSE _{mem}	2.40	2, 175	.09	.03
CSE _{TM}	.90	2, 175	.41	.01
Internet-specific epistemic beliefs	2.99	2, 175	.05*	.03
Perceived question difficulty	10.88	2, 175	< .001***	.11
Web as knowledge partner	1.23	2, 175	.29	.01
Anticipated future performance	5.26	2, 175	.01**	.06
Means (Standard Deviations) and Post-hoc Results				
	Web Search	Think Then Search	Answer Then Search	
<i>n</i>	61	58	59	
CSE _{think}	3.94 ^a (.52)	4.01 ^a (.56)	3.71 ^b (.62)	
CSE _{mem}	3.50 ^{a,b} (.81)	3.67 ^a (.82)	3.33 ^b (.87)	
CSE _{TM}	4.19 ^a (.47)	4.31 ^a (.50)	4.25 ^a (.47)	
Internet-specific epistemic beliefs	4.02 ^{a,b} (.54)	4.18 ^a (.46)	3.98 ^b (.43)	
Perceived question difficulty	2.32 ^a (.95)	2.52 ^a (1.05)	3.10 ^b (.83)	
Web as knowledge partner	3.30 ^a (.67)	3.17 ^a (.67)	3.11 ^a (.72)	
Anticipated future performance	72.95 ^a (22.46)	73.19 ^a (20.79)	62.20 ^b (19.72)	

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. Different superscripts across the same row indicate significant differences between experimental conditions using LSD post-hoc tests, $p \leq .05$.

not always have a greater effect on all outcome variables. Additionally, committing to an answer and subsequently searching the web (i.e., “answer then search”), might not *only* disrupt fluency but it may also serve to remove ambiguity about whether knowledge is internal or external, thereby diminishing the potential for knowledge source misattribution. Similarly, participants instructed to think or to type an answer before searching the web may have lower CSE than those who searched the web swiftly because thinking or answering can encourage people to monitor their knowledge more accurately. As Fisher and Oppenheimer (2021) demonstrated, ambiguity regarding the source of knowledge can work in a self-serving manner and its removal leads to more accurate metacognitive calibration (i.e., alignment of metacognitive judgments and task performance; Pieschl, 2009). Future studies should therefore more cleanly delineate knowledge monitoring from cognitive processing fluency.

Among other plausible alternative, yet complementary, explanations to strict dis/fluency accounts of knowledge source misattribution, (a) the degree to which there exists ready access to reliable external information (e.g., via the web) and (b) individual agency or control over information procurement (i.e., active information search) may also serve to blur internal and external information sources to the point that knowledge source misattributions and subsequent overestimations of one's own abilities may occur. Yet, it is unclear whether these factors – *access* to web-based information and *active search* – are important because they occurred in all experimental conditions in Study 1. These

explanations are therefore the basis for a follow-up study (Study 2), designed to further elucidate conditions under which knowledge source misattributions might occur in the information-rich environment of the web. Each is considered next, in turn.

Access to Reliable External Information via the Web

The web contains more information that is more readily available to more people than any data repository in human history. This tremendous information breadth and depth provide an unrivaled resource for factual information. In addition, using access devices that are widespread, easy to use, and highly portable makes this resource highly accessible. Relative to past information-seeking activities, entering keywords into a search engine is simple, fast, and effective, providing near-immediate relevant results. Given its scope and availability, the web is far more accessible than other external memory storage media, potentially rivaling the perceived accessibility of information stored in people's own heads (Ward, 2013a).

Access to web-based information can therefore become easily conflated with confidence in one's CSE or related capabilities because the boundary between internal, in-the-head memory and external, online information is potentially blurred (Fisher et al., 2021). Searching the web may therefore trigger an accessibility heuristic: if I have access to information, then I "possess" the information. This heuristic, in turn, can work to conflate internal and external memory sources. If people conflate access and knowledge, they may believe that they know the extensive amount of information on the web when in reality all they have is access, thus leading to greater CSE and related factors.

Several studies suggest that access to information is sufficient to increase people's perception of their own knowledge. Presumably publicly accessible information, for instance, can be perceived as being in one's possession, even if people don't actually have the information stored in their internal memory (Sloman & Rabb, 2016). For instance, merely watching YouTube instructional videos can give people the illusion that they actually possess skills depicted therein (Kardas & O'Brien, 2018). And, people tend to remember how to access information rather than the information itself (Sparrow et al., 2011), suggesting that people may also be prone to drawing false perceived equivalencies between accessing and knowing. Hypothesis 2 therefore proposes that access to web-based answers might influence people's metacognitive, information, and task judgments, relative to lack of such access:

H2_{a-d}: Access to web-based answers will evoke greater (a) cognitive self-esteem, (b), sense of the web as a knowledge partner, (c) anticipated future performance, and lower (d) perceived question difficulty, compared to lack of access to web-based information.

Active Information Search

Actively searching the web for information (e.g., by typing terms into a search engine and selecting from among displayed results), as opposed to passively receiving information through the web (e.g., by being provided with information from the web that was not searched for personally), can also contribute to the conflation of internal and external knowledge and elevated CSE and related factors. The agency implicated by proactively seeking information can spur heightened judgments of oneself. For example, actively searching the web for information, but not passively clicking a link to a website with the same information, has in past research led participants to become more confident in their ability to answer trivia questions in the future (Fisher et al., 2015). Similarly, Fisher et al. (2021) inferred that searching the web (versus being provided with information) prompted people to illusorily think they knew something when in actuality they did not, which detrimentally affected learning because it made people more likely to conflate internal knowledge with external knowledge and, in turn, caused people to be less likely to

commit the material to their internal memories. Hypothesis 3 thus proposes that the active process of searching for information, compared to being provided with answers, will influence people's judgments in the following ways:

H3_{a-d}: Performing a web search for answers will evoke greater (a) cognitive self-esteem, (b), sense of the web as a knowledge partner, (c) anticipated future performance, and lower (d) perceived question difficulty, compared to being provided with answers from the web.

To evaluate conditions under which knowledge misattributions might occur in the information-rich environment of the web, Study 2 compares (a) participants with ready access to external information sources compared to participants who receive no information and (b) those who actively search for answers versus those who are provided with answers without searching for them. Study 2 thus aims to test the effect of *accessing* web-based information and *active* information search (held constant in Study 1 since all participants searched the web) on CSE and other task and information judgments. Study 2 is further distinguished from Study 1 since it diminishes the levels of fluency, by focusing on conditions where in all cases people first provide their own trivia question answers. This focus (a) provides a more conservative test of the influence of the availability of web-based information on people's judgments (since Study 1 demonstrated that "answer first" conditions diminish knowledge source misattributions), (b) serves to control for variations in Study 1 on receiving or not receiving feedback and the temporal separation between question presentation and answers and, relatedly, (c) addresses whether committing to answers might actually counteract the higher CSE judgments seen in Study 1, since drawing attention to task cues such as answering questions has been shown to temper people's overestimation of themselves (Pieschl, 2021).

Study 2

Sample & Procedure

Participants in the US were recruited via Amazon's Mechanical Turk and the same methods to detect inattention as used in Study 1 were invoked in Study 2, resulting in 266 valid responses³ ($N = 266$). Participants were instructed that they would be answering some trivia questions, which would vary in difficulty and, consequently, they would likely know some but not all of the answers. They were also told that payment was not contingent on the number or correctness of their responses. Participants were instructed to provide answers to all trivia questions, including their "best guess" if necessary; they also had the option to indicate "I really don't know the answer." Participants were instructed *not* to use a search engine to look up answers to the questions, and to minimize the temptation to do so participants at this stage were told that at the completion of the task answers would be revealed to them. All participants were then presented with 15 medium-difficulty trivia questions (as used in Study 1, which were randomly counterbalanced in presentation order), one at a time, which they then answered to the best of their abilities.

After answering all 15 trivia questions participants were randomly placed into one of three conditions, which dictated what they did after answering the trivia questions. In the first condition ("web search;" $n = 87$) subjects were told that although they had previously been asked not to search the web, they should now use the search engine of their choice to verify or find, one at a time, answers to all of the trivia questions. In the second condition ("answers provided;" $n = 89$) participants were provided with the correct answers to all of the trivia questions, which they were told came from the web. In the final ("control;" $n = 90$) condition no further instructions were provided for participants and they did not see the trivia answers at this juncture. At this point all participants completed a post-stimulus questionnaire, after which subjects in the control condition were presented with the trivia question answers as promised.

In the “web search” and “answers provided” conditions, participants had access to external information, while in the “control” condition participants did not. The analysis for H2 therefore compares the “web search” or “answers provided” conditions against the “control” condition. In the “web search” condition, participants actively searched for information, while in the “answers provided” condition participants passively received information. The analysis for H3 therefore compares the “web search” condition against the “answers provided” condition.

Measures

Variables used in Study 2 were measured in the same manner as in Study 1, although the Internet-specific epistemic beliefs measure was dropped since (unlike in Study 1) some conditions in Study 2 did not require searching the web. Cognitive self-esteem dimensions included CSE_{think} ($M = 3.84$, $SD = .59$, Cronbach's $\alpha = .83$), CSE_{mem} ($M = 3.48$, $SD = .88$, Cronbach's $\alpha = .90$), and CSE_{TM} ($M = 4.14$, $SD = .58$, Cronbach's $\alpha = .79$). Responses for these variables and for *perceived question difficulty* ($M = 3.08$, $SD = .95$, Cronbach's $\alpha = .90$) and *perception of the web as a knowledge partner* ($M = 3.16$, $SD = .69$, Cronbach's $\alpha = .68$) ranged from 1 (*strongly disagree*) to 5 (*strongly agree*), while anticipated *future performance* ($M = 65.38$, $SD = 19.75$) was assessed from 0% to 100%. Electronic Supplementary Material 3 contains a confirmatory factor analysis of these measures, which indicated that the dependent measures are suitably distinct from each other.

Results

Hypotheses 2 and 3 were analyzed via a MANCOVA (with the method of answer derivation as the independent factor: web search, answers provided, control) with CSE_{think} , CSE_{mem} , CSE_{TM} , perceived question difficulty, web as knowledge partner, and anticipated future performance as the dependent variables. Because participants responded to the trivia questions prior to the induction in all conditions, the percentage of trivia questions answered by each participant was statistically controlled for (as a covariate) in all analyses to account for the possibility that having provided some portion of answers might affect the outcome measures.

Results showed a significant multivariate effect of method of answer derivation on the dependent variables and follow-up tests showed significant effects for CSE_{think} , CSE_{mem} , and CSE_{TM} , but not for the other outcome measures. Detailed multivariate, univariate, and post-hoc results are shown in Table 2. CSE_{think} scores were higher in the “web search” and “control” conditions (which did not differ from one another), versus in the “answers provided” condition. In addition, both CSE_{mem} and CSE_{TM} scores were greater in the web search versus in either the provide answers or the control conditions, which did not differ significantly from one another. Thus, support was found for H3_a for all forms of CSE, and there was modest and limited support for H2_a for CSE_{mem} and CSE_{TM} (but *not* for CSE_{think}), which were greater for web search (but *not* for answers provided) than in the control condition.

Study 2 Discussion

Results from Study 2 provide additional evidence for higher ratings for perceptions of one's own cognitive abilities under circumstances where accessing external information sources and actively searching the web for information might enable the misattribution of external information to one's self, than when opportunities for such knowledge source misattribution are fewer. Results (of H2) demonstrated that after providing question answers to the best of one's ability, having access to web-based answers (via searching for them) enhances how strong people believe their memory to be (CSE_{mem}) and the degree to which they believe they can find other information they don't have (CSE_{TM}), relative to a control condition. Importantly, the proposed effect of access via information provision was not supported, showing the importance of active web search as opposed to passive

Table 2. Results for Study 2.

Multivariate and Univariate Results					
	Wilks's lambda	<i>F</i>	<i>df</i> ₁ , <i>df</i> ₂	<i>p</i>	η^2
Multivariate					
Percentage of questions answered (control)	.76	13.52	6, 257	< .001***	.24
Method of answer derivation (experimental conditions)	.86	3.30	12, 514	< .001***	.07
Univariate					
<i>Percentage of questions answered</i>					
CSE _{think}		.94	1, 262	.33	.00
CSE _{mem}		.42	1, 262	.52	.00
CSE _{TM}		.89	1, 262	.35	.00
Perceived question difficulty		43.86	1, 262	< .001***	.14
Web as knowledge partner		7.05	1, 262	.01**	.03
Anticipated future performance		52.36	1, 262	< .001***	.17
<i>Method of answer derivation</i>					
CSE _{think}		3.97	2, 262	.02*	.03
CSE _{mem}		4.03	2, 262	.02*	.03
CSE _{TM}		3.16	2, 262	.04*	.02
Perceived question difficulty		.35	2, 262	.70	.00
Web as knowledge partner		2.72	2, 262	.07	.02
Anticipated future performance		.99	2, 262	.37	.01
Means (Standard Deviations) and Post-hoc Results					
	Web Search	Answers Provided	Control		
<i>n</i>	87	89	90		
CSE _{think}	3.91 ^a (.57)	3.69 ^b (.59)	3.92 ^a (.58)		
CSE _{mem}	3.70 ^a (.77)	3.38 ^b (.88)	3.36 ^b (.96)		
CSE _{TM}	4.28 ^a (.47)	4.08 ^b (.57)	4.08 ^b (.67)		
Perceived question difficulty	2.95 ^a (.95)	3.16 ^a (.94)	3.11 ^a (.95)		
Web as knowledge partner	3.12 ^{a,b} (.70)	3.31 ^a (.62)	3.04 ^b (.72)		
Anticipated future performance	66.95 ^a (18.93)	65.34 ^a (21.53)	63.89 ^a (18.78)		

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. Different superscripts across the same row indicate significant differences between experimental conditions using LSD post-hoc tests, $p \leq .05$.

access to web-based information. Thus, though access is important for metacognitive judgments like CSE, evidence suggests that it is *also* critical to actively search for such information, rather than to have it passively provided.

This was the essence of H3, which was supported in terms CSE outcomes for the most part. In this case, after people provided answers to the best of their own abilities, actively searching for answers on the web elevated CSE_{mem}, CSE_{TM}, and also CSE_{think}, or how intelligent people found themselves to be, compared to having answers passively provided from the web. Overall, then, though access to reliable external information is important for influencing metacognitive judgments, the act of proactively searching for information appears to be critical. Put another way, *how* one accesses external information sources seems to be an important factor implicated in the conflation of external and internal information sources.

That said, the results of Study 2 did not cleanly delineate the prediction in H2 (information access hypothesis: web search or answers provided vs. control) from that of H3 (active search hypothesis: web search vs. answers provided). Specifically, the web search condition produced greater CSE_{mem} and

CSE_{TM} than both the control condition *and* the answers provided condition, which could be interpreted simultaneously as support for H3 but as somewhat conflicting evidence for H2. Given that searching the web (H3) necessarily involves access to information (H2), and considering the pattern of results as a whole, it seems best to think of access as a necessary but insufficient factor for heightened CSE, while web search is a more important (and potentially sufficient) factor.

Taken together, the results of Studies 1 and 2 are commensurate with the view that people can make knowledge source misattributions when they search the web for information, erroneously attributing the external information they find to the internal knowledge they already possess. The results also suggest that the degree of misattribution is larger when people actively search the web in a cognitively fluent manner. As Ward (2021) explained: “The cognitive operations involved in searching Google are similar to those involved in retrieving facts from one’s own memory: A question is posed and, a short time later, an answer appears. Moreover, this information is delivered as unobtrusively as possible” (p. 2). As a result, people may fail to differentiate the information they found from the information they know, resulting in knowledge source misattribution.

The Role of Task Performance and Individual Competency

Although Studies 1 and 2 shed considerable light on the processes of knowledge source misattribution, they do not serve to discern whether participants’ judgments are linked to their actual *task performance*. In spite of its potential to inflate cognitive self-esteem, past research has largely ignored the role that individuals’ task performance accuracy plays in their subsequent metacognitive judgments, in the context of web search behaviors (for a notable exception, see Pieschl, 2021). Yet, establishing a link between baseline task performance (i.e., without the aid of a search engine) and one’s own perceived performance relative to others (also without using a search engine, but *after* having used one previously) would suggest additional judgments due specifically to search engine usage, which might serve to elevate confidence in subsequent tasks. Indeed, ambiguity regarding source information has been shown to lead to performance overestimation (Fisher & Oppenheimer, 2021) and searching the web for question answers, at least prior to providing them oneself, has also been linked to metacognitive overestimation (Pieschl, 2021).

Given the subsequent overconfidence that web search might invoke, such effects might be most pronounced among the least competent. The Dunning-Kruger effect (DKE), for example, has shown that less competent individuals (i.e., those performing less well on relevant tasks) tend to overestimate their performance relative to others, and that more competent people tend to some degree to do the reverse (Dunning, 2011; Kruger & Dunning, 1999). In the context of the present research, the question arises whether task competence drives one’s own perceived performance relative to others, in the presence of search engine use, and if this effect is more or less pronounced at lower versus higher levels of competence. This leads to RQ1, which is assessed in Study 3:

RQ1: Does a DKE exist in the context of online information search tasks and, if so, are there differences with regard to performing a web search, being provided with answers, and not searching for answers?

Study 3

Sample & Procedure

Participants in the US were recruited via Amazon’s Mechanical Turk. Safeguards against inattention were similar to those in studies 1 and 2, resulting in 472 valid participants ($N = 472$).⁴ The treatment for Study 3 was identical to Study 2: After answering 15 medium-difficulty trivia questions, participants were randomly placed into one of three conditions (“web search;” $n = 150$; “answers provided;”

$n = 153$; and “control;” $n = 169$). After either (a) searching the web to verify/find answers, (b) being provided with the answers, or (c) receiving no further instructions, respectively, participants completed a questionnaire that asked them to rate only their perceived performance on the trivia task relative to others and to respond to a series of demographic questions.

Measures

Competence scores were derived by awarding participants 1 point for each correct answer, 0 points for not providing an answer, and -1 point for providing an incorrect answer to each of the 15 trivia questions (as answered prior to the experimental stimuli).⁵ Competence scores thus potentially ranged from 15 to -15 for each person. Competence scores were used in turn to derive *percentile rank performance*, which is the comparative rank of each participant relative to all other participants’ performances (theoretical range from 1 to 99). Participants were placed into 1 of 4 *competence quartile groups* as evenly as possible (based on their competence score) for analyses. Consistent with Kruger and Dunning (1999), *relative estimated performance* was measured by asking all participants, upon their completion of the trivia task (following the experimental stimuli), “compared to others who also performed this trivia task, how do you think *you* performed?” Subjects used a slider to select their percentile ranking relative to others, from 0 (“I’m at the very bottom”), through 50 (“I’m exactly average”), to 99 (“I’m at the very top”).

Results

RQ1 was assessed by a three-way 4 (competence quartiles: 1 [low] to 4 [high]) \times 2 (performance score source: percentile rank [actual] performance, relative estimated performance) \times 3 (experimental conditions: web search, answers provided, control) mixed-model ANOVA. Detailed descriptive, multivariate, univariate, and post-hoc results are shown in Table 3. Follow-up tests probing a significant 3-way interaction of performance score source, competence quartiles, and experimental conditions indicated that in all conditions, consistent with classic DKEs, participants in quartiles 1 and 2 (lowest competence quartiles) assessed their own performance relative to others as significantly greater than it actually was. In quartile 3 actual and estimated performance aligned within each condition. However, estimated versus actual performance varied by condition in quartile 4 (highest competence): Whereas in the control condition (Panel C of Figure 1) participants significantly *underestimated* their own relative performance compared to their actual performance, those in either the web search (Panel A, Figure 1) or answers provided (Panel B, Figure 1) conditions failed to underestimate their performance, contrary to typical DKE patterns (for notes on addressing potential threats to DKE analyses, see Electronic Supplementary Material 1, Part IV). In this manner, the presence of the web as a knowledge partner appears to enhance a false sense of competence among the less competent (consistent with past DKE findings), and to suppress a sense of humility among the highly competent (in contrast to past DKE findings).

To probe results in terms of the estimated versus actual performance *differences* inherent in the DKE logic, each participant’s actual percentile performance score was subtracted from their relative estimated performance score, yielding a difference score representing people’s *performance estimation*. Performance estimation scores greater than 0 thus indicate overestimation of one’s own score relative to others and estimation scores less than 0 indicate underestimation (scores of 0 represent perfectly accurate estimated performance). A two-way 4 (competence quartiles: 1 [low] to 4 [high]) \times 3 (experimental conditions: web search, answers provided, control) ANOVA with performance estimation as the outcome measure was then performed. This analysis identifies if estimated performance varies by condition, within competence quartiles.

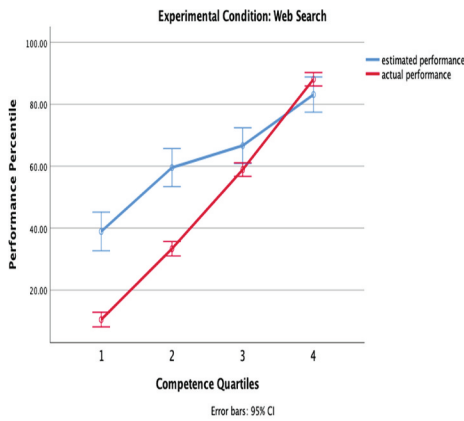
Results showed a significant interaction between competence quartile and condition (Wilks’s $\lambda = .97$, $F(6, 460) = 2.46$, $p = .02$, partial $\eta^2 = .03$). Follow-up contrasts (see Table 3) indicated that the overestimation evident among those in the lowest competence quartile was unaffected by

Table 3. Results for Study 3.

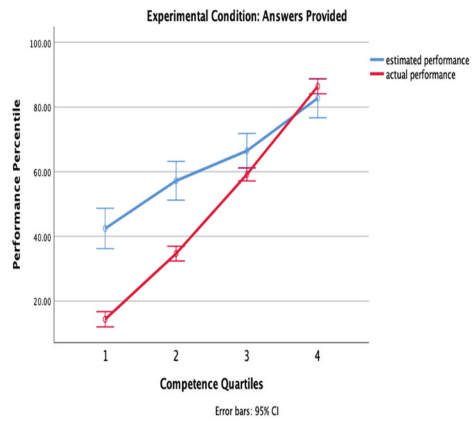
	Wilks's λ	F	df1, df2	p	η^2
Multivariate Results					
Performance score source	.71	191.25	1, 460	< .001	.29
Performance score source \times Experimental condition	.97	8.13	2, 460	< .001	.03
Performance score source \times Competence quartiles	.61	99.39	3, 460	< .001	.39
Performance score source \times Experimental condition \times Competence quartiles	.97	2.46	6, 460	.02	.03
Univariate Results					
Experimental condition		3.25	2, 460	.04	.01
Competence quartiles		580.61	3, 460	< .001	.79
Experimental condition \times Competence quartiles		1.06	6, 460	.39	.01
Means (Standard Deviations) and Post-hoc Results					

n	Web Search			Answers Provided			Control					
	Relative estimated performance	Actual percentile rank	Difference	Relative estimated performance	Actual percentile rank	Difference	Relative estimated performance	Actual percentile rank	Difference			
1st Quartile	34	38.91 (23.71)	10.44 (6.92)	28.47^a (22.47)	34	42.44 (21.54)	14.36 (6.02)	28.08^a (21.64)	42	43.31 (22.16)	10.59 (6.40)	32.72^a (23.50)
2nd Quartile	35	59.54 (21.29)	33.33 (5.72)	26.21^a (21.16)	37	57.19 (18.71)	34.66 (6.24)	22.52^a (18.10)	35	49.49 (20.97)	35.80 (6.42)	13.65^b (20.90)
3rd Quartile	40	66.65 (15.53)	58.90 (7.82)	7.75^b (13.57)	46	66.46 (15.41)	59.18 (7.87)	7.27^b (16.21)	51	59.31 (21.07)	62.51 (8.19)	-3.20^b (20.74)
4th Quartile	41	83.12 (12.00)	88.08 (6.82)	-4.95^b (9.40)	36	82.75 (11.90)	86.38 (6.63)	-3.63^a (11.97)	41	71.98 (14.09)	87.47 (7.92)	-15.49^b (11.54)

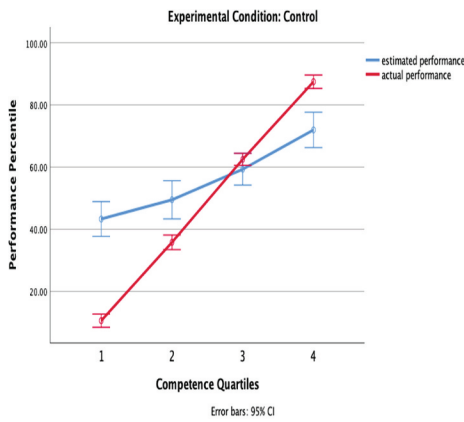
Difference scores are bolded to emphasize the Performance score source \times Experimental condition \times Competence quartiles interaction. Each difference score is calculated by relative estimated performance minus actual percentile rank; therefore, positive difference scores represent overconfidence and negative difference scores represent underconfidence. Different superscripts across the same row indicate significant differences between experimental conditions using LSD post-hoc tests, $p < .05$.



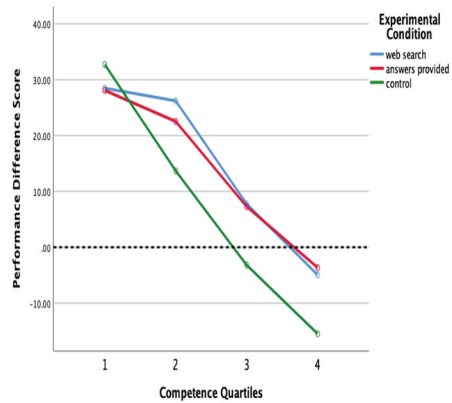
Panel A



Panel B



Panel C



Panel D

Figure 1. Study 3 performance scores.

Panels A – C: Performance percentile scores across competence quartiles, for actual and estimated performance; web search condition (Panel A), answers provided condition (Panel B), and control condition (Panel C). Panel D: Performance difference score (estimated minus actual performance score) by competence quartiles and condition; positive scores represent performance overestimation, negative scores represent performance underestimation; dashed line at zero represents accurate estimation.

condition; those in the middle 50% competence band (i.e., quartiles 2 and 3), however, significantly overestimated their performance *more* when they either were provided information from or searched the web themselves, relative to the control condition; and, although those in the highest competence quartile tended to *underestimate* their performance (i.e., scores below zero) across all conditions, those in the control condition did so significantly *more*, showing that the availability of web-based information served to inflate people’s relative estimated performance. This is illustrated in Panel D of [Figure 1](#).

Study 3 Discussion

Study 3 shows not only the novel finding that the DKE is evident in the context of online information, but also that both searching the web and the provision of answers from the web affect traditional DKE patterns relative to a control condition where web-based information is not explicitly invoked. At the lowest level of competency (1st quartile) participants overestimated their performance relative to others, which was evident to a similar degree across all three conditions – regardless whether they

searched the web, were provided answers, or were in a control group. People in the second competency quartile similarly overestimated their performance, but did so *more* if they had access to web-based information. Although relatively more competent people (quartile 3) were most realistic in their self-assessments, they still inflated their self-evaluations when they had access to web-based information, as compared to a control condition. And, at the highest competency level, access to web-based answers via search or information provision (versus a control condition) actually *erased* the traditional DKE (evident in the control condition) whereby people significantly *underestimate* their relative abilities. That is, access to web-based information prompted people *not* to underestimate their own relative performance. Thus, findings show both support for and countervailing evidence to the DKE, as a function of web search or receiving web-based information more passively.

General Discussion

Three distinct yet complementary mechanisms were proposed as important contributors to the blurring of boundaries between internal knowledge and external information and the cognitive misattributions that might result. Across three studies, findings demonstrated that cognitive processing fluency, access to reliable external information via the web, and actively searching for information each partially accounts for misattributions regarding the source of knowledge. In addition, task competence also interacts in important ways with people's judgments. Collectively, findings add considerable new insight regarding people's responses to near-ubiquitous access to contemporary information-saturated environments.

Study 1 showed that people make a wide variety of judgments due to cognitive processing fluency regarding (a) themselves (higher self-assessed intelligence [CSE_{think}]), (b) the task (better anticipated future task performance and lower perceived question difficulty), and (c) the environment (greater Internet-specific epistemic beliefs). Results thus corroborate the view that cognitive processing fluency "influences people's judgments across a broad range of social dimensions" (Alter & Oppenheimer, 2009, p. 219). Moreover, while findings are consistent with research examining metacognitive judgments (Stone & Storm, 2021; Ward, 2021), they also offer a novel extension to past work, which has tended to focus on judgments made only about the self (e.g., Ward, 2013a; cf., Fisher et al., 2021).

Study 1 results show that under conditions of higher cognitive processing fluency people appear to some degree to conflate the web's information with their own knowledge. Yet, when providing an explicit question answer oneself (versus not doing so), prior to searching the web for an answer, cognitive processing fluency is sufficiently disrupted to inhibit knowledge source misattribution and personal overconfidence. In this fashion, experience-based cues like cognitive processing fluency can serve either to promote knowledge source misattributions or to mitigate them, depending the degree to which such cues either mask or highlight the extent to which the web's information and one's own knowledge are distinct. This overarching finding suggests that the answer to the "open question if users' initial overestimation might persist even after answering knowledge questions with the Internet" (Pieschl, 2021, p. 113) might to some degree depend on cognitive processing fluency.

Yet, fluency explanations were not entirely or consistently upheld in Study 1. Study 2 therefore minimized the effect of cognitive processing fluency (by requiring participants to explicitly state an answer before being exposed to web information, which was the least fluent condition in Study 1) and concentrated on alternative – yet complementary – explanations of knowledge source misattribution and metacognitive judgments. Results showed that (1) *accessing* web-based information via search (versus not accessing information online, though *not* versus having answers provided for you) led to increased self-perceived memory ability (CSE_{mem}) and ability to find information (CSE_{TM}) and (2) *actively searching* the web for information (versus passively being provided with web-based information) led to higher self-assessed intelligence (CSE_{think}), memory ability (CSE_{mem}), and ability to find information (CSE_{TM}). Consistent with Fisher et al. (2015), the active search process, as opposed to merely viewing answers, is cardinal.

Together, findings from Studies 1 and 2 imply that although cognitive processing fluency may serve to blur the boundaries between internal knowledge and external information, it is not absolutely necessary for increasing the likelihood of knowledge source misattribution (although it may be sufficient as one method among several by which internal/external boundaries are conflated). In contrast, actively searching the web for information appears to be more essential, based on the results of Study 2 and previous findings by Fisher et al. (2015). Because all the experimental conditions in Study 1 involved searching the web, though, it is unclear whether searching the web is a necessary condition for the misattribution of external information to oneself. Additionally, one limitation in the present studies is that no conditions involved participants who obtained trivia answers via non-digital means. To bolster claims that the web is unique in terms of its effects due to the unparalleled breadth and depth of rapidly-attainable information (Ward, 2013b), future research can adopt experimental conditions that allow direct comparison between web-based information and non-web-based information.

Study 3 examined participants' self-assessed performance relative to others (rather than relative to their own future performance) and showed that, compared to a control condition, those of medium competency were more likely to overestimate their performance when web-based information was available, either via active search or by passive information provision. In addition, contrary to those to in a control condition (who *underestimated* their performance levels), those with the highest competency tended to estimate their relative performance when receiving web-based information as indistinguishable from actual performance levels. This is consistent with findings from Study 2 that provide some evidence suggesting that *access* to web-based information can heighten self-esteem, and adds that this effect is observed across all but the lowest competence task performers. Overall, this demonstrates the influence of individual-level factors – in the present case, actual performance level – on the extent to which metacognitive judgments like CSE are miscalibrated due to accessing the web for information.

Results of Study 3 also add context to the results of Studies 1 and 2. First, different people have different levels of susceptibility to metacognitive miscalibration and knowledge source misattributions. Study 3 results suggest that the weakest performers – who still grossly overestimated their relative performance – may be less susceptible to such misattributions *in the context of available web-based information*: The weakest performers who searched the web or were provided answers from it did not estimate their own relative performance more highly than those who were in the control condition. Yet, in terms of Study 1, further research is required to pinpoint how performance measures interact with cognitive fluency features. Second, there is an ironic outcome when strong performers misattribute information from the web to themselves: They actually end up being more accurate in their estimated relative performance (since they actually *underestimate* their relative performance when not using web-based information). Future research should therefore probe this finding by investigating whether the misattribution of information or the inflation of one's cognitive self-esteem is necessarily always a bad thing.

There is, however, also inconsistency between the results of Study 2 and Study 3. In Study 2, searching the web (an active process) led people to evaluate themselves more highly on CSE_{think} , CSE_{mem} , and CSE_{TM} than when being provided with answers (a passive process). In Study 3, however, searching the web *or* being provided with answers resulted in an approximately equal gap between people's relative estimated performance and their actual performance (the significant difference was when "web search" or "answers provided" were compared to the "control" condition). This distinction may be a consequence of the nature of the judgments being made: the individual agency differences between conditions in Study 2 might affect judgments of oneself (e.g., CSE), perhaps due to greater personal involvement with the search process, whereas when making comparative judgments against others (e.g., relative performance, as in Study 3), this distinction may be less consequential, since perhaps the mere existence of web-based information (and not agency in its procurement) is sufficient to prime a feeling of relative superiority to others. Alternatively, hindsight bias may be at play in the

outcome in Study 3 (given that obtaining the answers via any means produces a similar effect) but not in Study 2. Future research can consider methods to probe agency differences more fully and to isolate and test hindsight bias as an explanation.

Finally, because the 3 studies described here invoke disparate designs and focus on a variety of outcomes, the patterns of findings can be challenging to interpret collectively. For example, whereas Study 1's theoretical focus is on the role of cognitive processing fluency, Study 2 invokes a variety of relatively *disfluent* experimental conditions, in order to concentrate on the effects of information access and active search behaviors, while examining essentially the same outcomes. Although Study 3 replicates Study 2's method, its analytical emphasis is on the role that individuals' perceived task performance accuracy plays in their subsequent performance judgments relative to others, in the context of web search behaviors. Although this procedural variety provides significant depth of knowledge about metacognitive judgments, as intended, it can also be challenging to reconcile this variety across studies.

Yet, broad connections that exist between the studies' findings suggest promising avenues for future research that both highlight the high-level phenomena of interest and refine the specific features articulated in each study. Study 1 shows that under conditions of higher cognitive processing fluency, where knowledge source misattributions are more possible, people can bolster positive self- and task-judgments, perhaps as a function of not committing fully to responses that could highlight their personal shortcomings or task difficulties. Study 2 shows that even *after* first committing to a personal question response, the subsequent process of actively searching for web-based answers can lead to higher metacognitive judgments (i.e., CSE). Study 3 shows that the availability of web-based information, *regardless* of people's agency in obtaining it, appears to inflate people's self-assessed relative competence. Overall, and in spite of notable differences among studies, findings show that the web appears to serve to embolden people's self- and task-judgments through a series of cognitive reflections that enable misattributions.

To elaborate on or extend these nascent findings therefore requires systematically investigating opportunities for misattribution, while honing in on the key processes and outcomes of interest. For example, future research might (a) vary the degree to which people are reasonably able to misattribute external information as internal knowledge by, for example, providing answer feedback that explicitly in/validates people's initial assessments; (b) modulate the degree to which people commit to their own instincts or question responses, for instance, by requiring them to publicly or privately state their views, either prior to or after searching for or being provided with correct (or seemingly correct) responses; (c) systematically alter the relative agency people have in information procurement, for example, by selecting answers from a variety of static sources (such as existing lists) or via more active web searches; or (d) manipulate perceived competence by (sometimes false) feedback on initial question answers, in an attempt to pinpoint the thresholds at which perceived competency affects people's judgments. Importantly, the underlying theoretical mechanisms articulated in the present studies can be invoked across any of these manipulations in order to clarify the reasons *why* outcomes may occur. In this fashion, the wide variety of phenomena implicated in the present studies can be methodically probed to better articulate the commonalities and relevant differences inherent in the present explanations, thereby adding important refinements within this new research domain.

As near-ubiquitous digital devices are increasingly used as memory aids in people's daily lives the need to understand how people make metacognitive judgments based on their web search experience or lack thereof also becomes more pertinent. To this end, findings across 3 studies have shown that cognitive fluency, access to web-based information, and actively searching for information can influence metacognitive indicators like CSE, and that task performance differences are also implicated in such outcomes.

Notes

1. Based on effect sizes of $\eta_p^2 = .027$ and $\eta_p^2 = .039$ for two studies in the same trivia questions/metacognitive judgment paradigm described in Hamilton and Yao (2018), the average effect size of $\eta_p^2 = .033$ was taken to estimate the number of participants required to detect a significant effect at 80% power for a MANOVA with 3 experimental conditions and 7 dependent variables. Assuming a correlation of $r = .50$ between the dependent variables, G*Power analyses showed that a sample size of $N = 165$ was required.
2. The “think then search” condition in the present study bears some similarity to Experiment 6 in Ward (2021), in which participants in a “slow Google” condition also contemplated trivia answers before obtaining the answers from the web. Whereas the “think then search” condition in the present study had a delay of 6s, the “slow Google” condition in Ward (2021) had a delay of 25s. This difference in time is one potential reason why “slow Google” led to lower CSE judgments than searching the web normally in Ward’s (2021) study, but the “think then search” condition was comparable to the “web search” condition here. That is, participants in Ward’s (2021) study may have had more time to realize that they do not know the answers, resulting in less blurring of internal/external information boundaries for them than for participants in the present study.
3. Based on an effect size of $\eta_p^2 = .033$ (mean effect size across two studies in Hamilton & Yao, 2018) and assuming a correlation of $r = .50$ between dependent variables, G*Power analyses showed that a sample size of $N = 168$ was required to detect a significant effect at 80% power for a MANOVA with 3 experimental conditions and 6 dependent variables.
4. Assuming a small-to-medium effect size estimate ($\eta^2 = .03$, $f = .176$; see Cohen, 1992), a power analysis using MorePower (Campbell & Thompson, 2012) estimated that a sample size of $N = 456$ was required to appropriately detect a 3-way mixed model ANOVA interaction effect at .80 power.
5. Alternative coding schemes, such as coding incorrect responses as 0 instead of -1 , generated equivalent findings along the most critical dimensions to those reported.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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References

- Alter, A. L., & Oppenheimer, D. M. (2009). Uniting the tribes of fluency to form a metacognitive nation. *Personality and Social Psychology Review*, 13(3), 219–235. <https://doi.org/10.1177/1088868309341564>
- Bråten, I., Strømso, H. I., & Samuelstuen, M. S. (2005). The relationship between Internet-specific epistemological beliefs and learning within Internet technologies. *Journal of Educational Computing Research*, 33(2), 141–171. <https://doi.org/10.2190/E763-X0LN-6NMF-CB86>
- Campbell, J. I., & Thompson, V. A. (2012). MorePower 6.0 for ANOVA with relational confidence intervals and Bayesian analysis. *Behavior Research Methods*, 44(4), 1255–1265. <https://doi.org/10.3758/s13428-012-0186-0>
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155–159. <https://doi.org/10.1037/0033-2909.112.1.155>
- Dunning, D. (2011). The Dunning–Kruger effect: On being ignorant of one’s own ignorance. In J. Olson & M. P. Zanna (Eds.), *Advances in experimental social psychology* (Vol. 44, pp. 247–296). Academic Press.
- 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. <https://doi.org/10.1037/xge0000070>
- Fisher, M., Smiley, A. H., & Grillo, T. L. (2021). Information without knowledge: The effects of Internet search on learning. *Memory*, 1–13. Advance online publication. <https://doi.org/10.1080/09658211.2021.1882501>
- Fisher, M., & Oppenheimer, D. M. (2021). 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>
- Gignac, G. E., & Zajenkowski, M. (2020). The Dunning–Kruger effect is (mostly) a statistical artefact: Valid approaches to testing the hypothesis with individual differences data. *Intelligence*, 80, 101449. <https://doi.org/10.1016/j.intell.2020.101449>
- Graf, L. K., Mayer, S., & Landwehr, J. R. (2018). Measuring processing fluency: One versus five items. *Journal of Consumer Psychology*, 28(3), 393–411. <https://doi.org/10.1002/jcpy.1021>

- 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>
- Kammerer, Y., & Gerjets, P. (2012). Effects of search interface and Internet-specific epistemic beliefs on source evaluations during Web search for medical information: An eye-tracking study. *Behaviour & Information Technology*, 31(1), 83–97. <https://doi.org/10.1080/0144929X.2011.599040>
- Kardas, M., & O'Brien, E. (2018). Easier seen than done: Merely watching others perform can foster an illusion of skill acquisition. *Psychological Science*, 29(4), 521–536. <https://doi.org/10.1177/0956797617740646>
- Kelley, C. M., & Lindsay, D. S. (1993). Remembering mistaken for knowing: Ease of retrieval as a basis for confidence in answers to general knowledge questions. *Journal of Memory and Language*, 32(1), 1–24. <https://doi.org/10.1006/jmla.1993.1001>
- Kelley, C. M., & Jacoby, L. L. (1996). Adult egocentrism: Subjective experience versus analytic bases for judgment. *Journal of Memory and Language*, 35(2), 157–175. <https://doi.org/10.1006/jmla.1996.0009>
- Koriat, A. (1997). Monitoring one's own knowledge during study: A cue-utilization approach to judgments of learning. *Journal of Experimental Psychology: General*, 126(4), 349–370. <https://doi.org/10.1037/0096-3445.126.4.349>
- Koriat, A., Nussinson, R., Bless, H., & Shaked, N. (2008). Information-based and experience-based metacognitive judgments: Evidence from subjective confidence. In J. Dunlosky, & R. A. Bjork (Eds.), *Handbook of metamemory and memory* (pp. 117–135). Psychology Press.
- Krueger, J., & Mueller, R. A. (2002). Unskilled, unaware, or both? The better-than-average heuristic and statistical regression predict errors in estimates of own performance. *Journal of Personality and Social Psychology*, 82(2), 180–188. <https://doi.org/10.1037/0022-3514.82.2.180>
- Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121–1134. <https://doi.org/10.1037/0022-3514.77.6.1121>
- Laham, S. M., Alter, A. L., & Goodwin, G. P. (2009). Easy on the mind, easy on the wrongdoer: Discrepantly fluent violations are deemed less morally wrong. *Cognition*, 112(3), 462–466. <https://doi.org/10.1016/j.cognition.2009.06.001>
- 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>
- Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and some new findings. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 26, pp. 125–173). Academic Press.
- Pieschl, S. (2009). Metacognitive calibration—an extended conceptualization and potential applications. *Metacognition and Learning*, 4(1), 3–31. <https://doi.org/10.1007/s11409-008-9030-4>
- Pieschl, S. (2021). Will using the Internet to answer knowledge questions increase users' overestimation of their own ability or performance? *Media Psychology*, 24(1), 109–135. <https://doi.org/10.1080/15213269.2019.1668810>
- 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
- Schwarz, N., Sanna, L. J., Skurnik, I., & Yoon, C. (2007). Metacognitive experiences and the intricacies of setting people straight: Implications for debiasing and public information campaigns. *Advances in Experimental Social Psychology*, 39, 127–161. [https://doi.org/10.1016/S0065-2601\(06](https://doi.org/10.1016/S0065-2601(06)
- Serra, M. J., & Dunlosky, J. (2005). Does retrieval fluency contribute to the underconfidence-with-practice effect? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31(6), 1258–1266. <https://doi.org/10.1037/0278-7393.31.6.1258>
- Slovan, 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. <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. (2015). Saving-enhanced memory: The benefits of saving on the learning and remembering of new information. *Psychological Science*, 26(2), 182–188. <https://doi.org/10.1177/0956797614559285>
- Thompson, V. A., Turner, J. A. P., Pennycook, G., Ball, L. J., Brack, H., Ophir, Y., & Ackerman, R. (2013). The role of answer fluency and perceptual fluency as metacognitive cues for initiating analytic thinking. *Cognition*, 128(2), 237–251. <https://doi.org/10.1016/j.cognition.2012.09.012>
- Ward, A. F. (2013a). *One with the Cloud: Why people mistake the Internet's knowledge for their own* [Unpublished doctoral dissertation]. Harvard University.
- 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). <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.