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Reply

Cognition in the Internet Age: What are the Important Questions?

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The internet is rapidly changing how we find and share information, serving as a "digital expansion of the mind" that is almost always available and easy to use (Marsh & Rajaram, 2019). In our target article, we drew on basic cognitive science findings as well as research on other external memory devices to discuss and make predictions about "cognition in the internet age." Seven commentaries replied to our article; they raised many interesting and important points, too many for us to summarize here. Our reply identifies five questions highlighted by the commentaries that we believe are critical for the future course of research, beginning with whether the internet is any more likely to change cognition than past technological advances, and then clarifying what we mean by "changing cognition." The third question addresses the agency of internet users, in part because the commentaries sometimes diverged on this issue. We then touch briefly on the relevance of individual differences in the internet age before concluding with implications for the basic science of memory. To be clear, these five questions are not exhaustive with respect to either the ideas presented in the commentaries or the many considerations about the mind-internet interaction that will continue to emerge. Instead, we draw these questions from the ideas presented in our target article and the commentaries to offer a research framework for students of memory and cognition.

Question 1: Is the Internet Really Different?

Several of the commentaries note how new technologies often bring questions about the implications for human cognition (Hamilton & Benjamin, 2019; Russell, 2019; Yamashiro & Roediger, 2019). In effect, the question is whether "the internet [is] a qualitatively different shift in technology, or. . . solely the technology of the moment" (Russell, 2019)? Yamashiro and Roediger (2019, Table 1) directly compare the properties of the internet to those of other technological innovations, such as radio and television. In that sense, we agree the internet is not that new—but there are also major differences in the ways in which the internet is permeating our mental lives compared to, say, radio or television. For example, radio and television provide easy and fast access to information, but at any given time the information one is searching for may simply not be available. (Imagine relying on these sources if you suddenly wanted to know the capital of Madagascar, for example.) Of course, it's not simply a matter of all content being available; as Hamilton and Benjamin (2019, p. 43) note, "one cannot become an expert birder by having a hard drive full of bird photos," but that concern is true whether one hoards bird books or listens to bird songs on the radio. What is particularly striking, and unique, about internet use is its interactive nature. The internet allows the user

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to easily and rapidly probe for information, store and retrieve information, or engage in social interaction in ways that prior technological tools did not. Will this change the user's memory and cognition? This is an empirical question.

Question 2: What does it Mean to Change Cognition?

We believe the internet is such a dramatic change that we raised the question of whether it changes cognition, but what does that question mean? Risko (2019) used an analogy about furniture to illustrate how this question might be interpreted differently; treating furniture as cognitive processes, the question is whether one gets new furniture or rearranges the existing furniture. We certainly did not mean to imply a complete redecoration of the cognitive landscape—change in an evolutionary sense happens over a much longer time scale. But we do know that extensive experience can lead to local structural changes in the brain; experienced cab drivers, for example, have larger posterior hippocampi and smaller anterior hippocampi than control subjects (Maguire et al., 2000). So, in structural terms, to the extent that people's experiences and behaviors shift in a persistent way with technology, such changes may eventually be reflected in the brain's architecture over a long time period.

As Risko (2019) notes, the less controversial question involves asking whether internet usage changes the particular processes brought to bear—for example, people may be less likely to retrieve information from memory and instead rely on different cognitive processes to find the information online. Is this simply rearranging the furniture, or is it changing the size of the furniture? It doesn't change the basic process of retrieval if people do it less often than they did pre-internet, but it may make it less prominent in the room. Experimentally, the comparisons are between an individual working on her own and an individual with access to the internet. Different processes might be activated, or the relative reliance on various process might change when, for example, one uses the internet to search for, communicate, and edit information, as compared to doing the same things offline in more traditional environments.

Question 3: How much Agency does the Internet User have?

As Wang (2019) emphasizes in her commentary, when we search for information on the internet or use social media to connect with others, we as users decide what to search for, which links to click, whom to follow, or what to edit. Our personal history guides these decisions and our selections customize the search engine (e.g., Google) results further. Of course, we can also choose the books we read, who we mail our photos to, and whether or not we listen to a particular speaker, among many other choices. However, as we noted in our target article, the internet provides exponentially more choice points than do traditional media, and in this sense allows more agency and is "shaped by the people who use it" (Hamilton & Benjamin, 2019, p. 42).

Nonetheless, as Russell (2019) notes in his commentary, the results to our searches are constrained—for example, by the system design and the user interface. Willingham (2019) notes that people rarely look beyond the first page of google results, but what appears on the first page of results may be paid sponsorships or driven by what other people are currently searching for. Algorithms select and order content, and we can only gather what the system and the user interface deliver. A similar issue arises with social media; for example, an algorithm determines which stories and posts are prominently displayed in our news feeds. In both cases, our agency drives what stories and posts we seek, but our choices are limited by the structure of the system.

We can also ask whether agency is always positive. As discussed in our target article, people can search for information that confirms their beliefs and join echo groups that reiterate their worldview. Agency in this manner can lead to attitude polarization (Wang, 2019) and shape cognitive structures in increasingly constrained ways. Also, our agency at one point in time provides fodder for distraction at another, leading to advertisements peppered on the page that reflect the user's history of online shopping.

Another interesting question involves the conclusions users draw when they fail to find what they are looking for. The internet may appear bottomless in terms of content but as Willingham (2019, p. 21) notes "...you actually can't always find what you hope to [find]." Furthermore, once-working links disappear and content changes (Russell, 2019). Such missing information may lead the user to incorrectly assume that the information does not exist at all, or is not worth knowing (Russell, 2019) when perhaps the problem is that the information simply does not exist on the internet or the user did not choose search terms wisely.

Question 4: What about Individual Differences?

Cognitive psychologists often do not examine individual differences, preferring to focus on general cognitive processes (the major exception being working memory, which clearly varies across people, with predictive power for many tasks; e.g., Engle, 2018). In a recent target article in this journal, Logie (2018) makes a very persuasive argument that such an approach risks losing important information. Oftentimes there is more than one way to approach a task; for example, people vary in their ability to form mental images, with corresponding differences in the brain areas activated when they mentally rotate figures (Logie, Pernet, Buonocore, & Della Sala, 2011). In the same way, people vary in how they use the internet. For example, a minority of users is responsible for the majority of content, resulting in substantially more "followers" than content creators on social media (Wang, 2019). In another example, by one estimate, 2% of the population suffers from internet addiction (Poli, 2017). They experience problems such as the prioritization of online over real life relationships or excessive online gambling or shopping. Working memory will matter (it likely predicts susceptibility to clickbait and advertisements, for example), but so too will personality, social connectedness, and even boredom. Individual differences remain important even as we ask whether the individual is still the ideal unit of analysis in an environment where group interactions are common

(Yamashiro & Roediger, 2019; Risko, 2019). Asking and answering questions about why some people use the internet so differently than others (and what consequences that may have for belief and memory) will clarify both individual and group behavior.

Question 5: What are the Implications for the Science of Memory?

The commentaries suggested ways that "cognition in the internet age" may change the science of memory. In this context, we anticipate at least two major themes for how the cognition–internet interaction may change the questions we ask going forward.

First, are the same processes recruited when people use the internet to perform tasks once done purely offline? It will be important to determine whether the concepts and units described in traditional memory textbooks are useful when examining how remembering works when interacting with the internet. In this vein, Storm (2019) asks how to define memory retrieval in the internet age, when something might be easily and quickly retrieved via one's smartphone but not when relying on one's own memory (see Risko, 2019, for a similar point about metacognition). Hamilton and Benjamin (2019) ask about forgetting in the internet age; for example, social media may remind one of a memory one would rather forget, and web pages with errors are cached and may reappear. It is worth asking ourselves what concepts are useful, and which may have to be modified, to capture cognition in this context. Analogous to the switch from oral traditions to the written word, the internet has shifted the information processing environment, inviting us to expand the questions we ask about the science of memory.

Second, this change in the environment may also shift the specific topics that engage memory scientists. The topics we study are often influenced by the events of the world; prime examples include people's so-called flashbulb memories (e.g., Brown & Kulik, 1977) and reports of recovered memories (e.g., Loftus, 1993). In the internet context, much attention has been devoted to fake news and the proliferation of misinformation (the "weaponization of misinformation" as Hamilton & Benjamin, 2019, describe it). Another example comes from education, as explored in Willingham's (2019) commentary. Whether or not one believes personalized learning to be a good thing, cognitive psychologists are likely to be attracted to the tremendous amounts of data such systems are collecting in actual classrooms.

Conclusions

A good research approach requires precisely testing one's hypotheses, developing a strong theoretical framework to offer explanation, and knowing which questions are important to ask. Here we have focused on the third component, with the title of our response (Cognition in the Internet Age: What are the Important Questions?) deliberately borrowing from Neisser's famous question, *Memory: What are the important questions?* Neisser (1978) argued for the importance of asking questions about how memory is used in the world. To the extent that the internet is changing the world and pervading our mental lives, it will suggest different research questions, and in this sense we will understand how the internet changes cognition.

Author Contributions

Suparna Rajaram and Elizabeth J. Marsh participated equally in the preparation of this manuscript.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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