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The Effect of Google on Memory Retrieval: Internet Searching as a Negative Prime

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Abstract. People have a near constant ability to access the internet and search for anything they want to know. By having Google searching available, they may not utilize their memory to its full capability. This study examined how memory retrieval is affected by priming Internet searching. Three groups of participants (*N*=48) took a condensed version of a general knowledge norms test after being primed with Internet searching by varying degrees. If the participants were unsure of an answer, they either left it blank or looked it up on Google. More questions unanswered or looked up on Google signified greater blocking and less memory retrieval. I predicted that participants' memory retrieval would decrease as the strength of the prime increased. This study found that when Google is available, people tend to rely on their memory significantly less than when they cannot access Google. This may lead to decreased cognitive ability and deficits in memory function over time.

External Memory

Searching the Internet to find information has become extremely common in recent years. With society's near constant access to smart phones, tablets and laptops, people can connect to the Internet and find nearly anything they want to know. When they want to know the answer to a question, they can "Google it." The Internet, in this regard, is a source of external memory. Clark and Chalmers' (1998) extended mind hypothesis states that, in humans, cognitive processes take place within and even beyond the central nervous system. These processes, including memory, extend beyond us as we offload information onto the environment (Menary, 2010). The Internet has quickly become a massive place to offload many types of information including current and historical facts, pictures, memories, and even what you ate for breakfast.

Little research has been done on the effects of using the Internet as an external source of memory. However, one important study was done by Sparrow, Liu, and Wegner (2011). They found that, when using a computer and the Internet as a source of external memory, the location of where to find information is typically remembered rather than the information itself. This allows individuals to easily access more information than memory does alone. Although this may be convenient and perhaps adaptive, it may also bear negative consequences. Sparrow et al. (2011) also found that information which people expect to have access to in the future tends to be forgotten, whereas information considered not readily accessible later tends to be remembered. This likely happens because people do not rehearse the information in working memory, so it is not encoded or transferred to long-term memory (Lucidi et al., 2016; Rose, Craik, & Buchsbaum, 2015). With near constant Internet access and the ability to search for an astounding amount of information, people expect to have continual access to nearly all information. When they only need to know where to find the information, the information itself is not encoded and, therefore, forgotten.

Relying too heavily on external memory sources can be problematic, as there are times when information in internal memory is vital to performance. If people become too reliant on the Internet for memory and knowledge, they will not be able to problem solve, engage in deep thought, or communicate about a topic (Nestojko, Finley, & Roediger, 2013). People need to possess the information in their internal memory to have higher order cognitions about the information.

Another possible negative effect of reliance on external memory involves the retrieval of information. When information is already in long-term memory, retrieval of that information is important to prevent transience, the gradual fading of memories (Ebbinghaus, 1885; Schacter, 1999). This is known as the "use it or lose it" phenomenon (Shors, Anderson, Curlik II, & Nokia, 2012). Using the internet to search for information only strengthens the knowledge on where to find it, so the information is not deeply processed and, therefore, more likely to be forgotten (Loaiza, McCabe, Youngblood, Rose, & Myerson, 2011; Rose et al., 2015). Repeated retrieval of information from internally stored knowledge helps people remember information and also aids in understanding and solving new problems (Butler, 2010). With less retrieval, the information is more likely to be lost, and cognition pertaining to that information will be significantly reduced. A balance between external and internal memory is ideal so that people can have access to the vast array of information the Internet provides but still preserve their internal memory (Nestojko et al., 2013).

Priming

First proposed by Daniel Schacter (1987), priming is a form of bias in cognitive processing that can unconsciously facilitate the retrieval of certain memories, among other things. Sparrow et al. (2011) looked at effects of priming in several experiments. They found that, when an answer is unknown, people tend to think of computers. Additionally, when thinking of knowledge in general, thoughts of computers may also be primed. Moreover, when asked a question, especially a hard question, thoughts of Internet searching are primed. This is a particularly significant finding; if people tend to automatically think of searching the Internet when asked a question, they may not use the information they have stored in their memory, leading to loss of memory and reduced ability for higher-order cognitions.

There are two major ways that priming presumably affects retrieval. Wimber, Alink, Charest, Kriegeskorte, and Anderson (2015) as well as Hellerstedt and Johansson (2016) found that, in retrieval, associated memories seem to compete. One memory is selected for retrieval and is remembered more clearly. The unselected memory is then suppressed and more likely to be forgotten (Wimber et al., 2015). When Internet searching is primed, it may compete with memories of the information itself, suppressing the information and causing it to be forgotten.

Another possible explanation follows the hypothesis that primes can be inhibitory and distracting to retrieval of other information. These primes are called negative primes (Houghton, Tipper, Weaver, & Shore, 1996; Ortells, Noguera, Abad, & Lupianez, 2001; Tipper, 1985; Tipper & Cranston, 1985). Complementary to this, Vandierendonck (2016) proposed that the central executive problem-solves in working memory by following specific rules that make problem solving go more quickly and is satisfied when it finds a route to the information or knows a route can be searched when it is unknown. When internet searching is primed, the central executive automatically sees that a route can be searched and, therefore, does not need to find a route to the information in memory. In other words, the prime of internet searching inhibits the central executive from retrieving information. It is also possible that both competition and inhibition play a role, as proposed by Verde (2009).

Present study

Based on this research, I believed that participants would perform more poorly on a memory retrieval task, because the priming of Internet searching would lead to competition and suppression of memories, with the searching also acting as a negative prime by inhibiting retrieval of information. I predicted that having Google searching as a viable option to find information hinders an individual's memory usage. In particular, priming Internet searching was expected to decrease memory retrieval. To test this, I had participants take a general knowledge test and primed them at different levels with Google. I hypothesized that the "no Google" group, having been told their memory system would be compared with Google searching, would perform more poorly in retrieval than the control group. Furthermore, the participants with access to Google would have the worst retrieval performance. I predicted that the control group would rely on their memory more to answer the questions, whereas the experimental groups would be primed to think of Internet searching and therefore not utilize their memory to their best ability, with the effect increasing with the stronger prime. The present study is important because it can show the negative effects of the Internet on internal memory retrieval and have implications for everyday life.

Method

Participants

The sample was comprised of 48 undergraduate students, all obtained by using a convenience sample of students from Minnesota State University Moorhead. Some students received instructor-approved extra credit in their psychology courses for participating, while other students chose to participate as part of an alternative course assignment. A sign-up sheet was posted outside the Psychology Department offices entitled, "General Knowledge and Memory." Fifty-seven participants were recruited, but only data from 48 participants were used. To prevent error due to age differences in technology use (Van Volkom, Stapley, & Malter, 2013), only data from students between the ages of 18 and 29 were analyzed. Data from participants who were exchange students were also not included, as their general knowledge was expected to be qualitatively different than the general knowledge of students who grew up in the United States.

Materials

Participants took a general knowledge test containing 25 questions from Tauber, Dunlosky, Rawson, Rhodes, and Sitzman's (2013) updated version of Nelson and Narens's (1980) general knowledge norms. The 299 questions on the general knowledge norms were separated into five categories based on the percentage of norming participants that answered it correctly. The percentages range from 0 - 93.3% and the cutoff percentages for each category, starting at 0, were: 19%, 38%, 57%, 76%, and 93.3%. Because of the students' limited time, five questions from each category were randomly selected and randomized for the test. Examples of questions from the test include: "What is the name of Dorothy's dog in the Wizard of Oz?" and "What is the name of the largest ocean on Earth?" (For the full list of possible questions, see the 2013 article by Tauber, et al.). The updated general knowledge norms demonstrate good generational stability from the older version with a Spearman correlation (ρ) of .83.

Participants also completed a demographics survey of age, sex, and class standing. Included on the survey were two 7-Point Likert scales that measured the frequency of Internet use and Google use, from *never* (1) to *very often* (7).

Other items that participants encountered included a desktop computer, keyboard, mouse, and pen. The computer had one Google Chrome web browser open to the Google search engine. A pen was chosen rather than a pencil to more easily track changes and mistakes.

Procedure

At their allotted time, participants went to a room a containing a table and three chairs. Before beginning the study, participants provided their name, listened to an introduction of the study, and signed an informed consent form.

Participants were then randomly assigned to one of the three groups: the control group, the first experimental group (no Google), or the second experimental group (Google). They were taken to another room that contained a computer, but the computer was hidden behind a partition for the control group. In the experiments of Sparrow et al. (2011), participants performed tasks on a computer, so the presence of the computer may have served as an additional prime. In the present study, the computer was not present for the control group to prevent this priming. The computer screen was on and open to the Google search engine for the experimental groups. The participants in the "Google" group sat in a chair next to the computer, and the "no Google" group sat at a chair in front of the computer. The control group sat at a different table in the room.

Next, each of the three groups received a packet with different written directions and the general knowledge test. The control group's set of directions included a statement saying they were being tested on their general knowledge. The "no Google" group's set of directions included a statement saying their general knowledge was being tested compared to when Google searching is available as an aid, necessitating the prohibition of Google searches to answer any questions. Both the control group and the "no Google" group were told to leave the question unanswered if they were unsure of an answer. The "Google" group's set of directions included a statement saying they were being tested on their general knowledge and their ability to use Google searching for assistance when needed. These participants were told that they were free to search Google if they did not know the answer. The remaining instructions for all three groups were nearly identical.

After reading the instructions, participants were instructed to turn the page in the packet and take the general knowledge test. The control group and the "no Google" group had ten minutes to complete the test, whereas the "Google" group had fifteen minutes. Once they had finished or time had run out, participants handed their tests to the researcher. They were then given a demographic information form with questions about their internet and Google usage. Upon completion, their test and demographic form were stapled together and placed into an envelope. Participants were debriefed orally, received a written debriefing statement, and were given a certificate of completion to turn in to their instructors for credit.

Results

A One-Way ANOVA was conducted to measure any differences between the numbers of questions that were answered incorrectly between the three groups. This was done to check if each group understood their respective instructions for unsure answers, such as leaving the answer blank or looking it up rather than guessing an incorrect answer. There were no significant differences between the number of incorrect answers, $F(2, 45) = 1.23$, $p > .05$. This shows that the construct of "unsure answers" was valid and the instructions were clear. See Figure 1.

Another One-Way ANOVA was conducted to measure the differences between the effects of the levels of the Google prime on memory retrieval. There were significant differences between the number of unsure answers in the three groups (control, no Google, and Google), F (2, 45) = 14.17, p < .05, η^2 = .39. Tukey's HSD was conducted to identify the precise pattern of the differences between the groups. The participants in the control group (M = 9.59, SD = 4.18) and the "no Google" group (M = 11.27, SD = 3.97) were unsure of the answers to the same number of questions, p > .05. This finding was inconsistent with my hypothesis. However, the participants in the "Google" group, (M = 16.69, SD = 3.74) were unsure of significantly more answers than both the control group, p < .05, and the first experimental group, also p < .05. See Figure 2.

Correlations were also computed to see if there were any relationships between the frequency of participants' Internet or Google usage reported on two 7-point Likert scales and the number of unknown answers. The frequency of Internet usage (M = 6.2, SD = .80) and the number of unsure answers (M = 12.48, SD = 4.96) were not correlated, r (46) = -.11, p > .05. There was also no correlation between Google usage (M = 5.69, SD = 1.19) and the number of unsure answers, r (46) = -.01, p > .05.

Discussion

This study hypothesized that as the strength of the Google prime increased, the number of unsure answers to questions would also increase. It was believed that the prime would inhibit, or block, the retrieval of information from memory (Wimber et al., 2015) and instead facilitate Google searching (Sparrow et al., 2011). This hypothesis was partially supported by the data. The participants who could utilize Google relied significantly less on their memory than the participants unable to use Google and those not primed with Google. Internet searching served as a negative prime when it was available (Tipper, 1985). Google searching won when competing with retrieval of the information from memory (Hellerstedt & Johanssen, 2016; Wimber et al., 2015), likely because it is seen as a simpler and possibly more accurate problem-solving mechanism (Vandierendonck, 2016).

There are very important implications to these findings. Since people are constantly connected to the Internet, they can search for answers whenever they want. Instead of using their memory to retrieve information that is stored, they can use Google to answer for them. By doing this, people are not using the neural pathways to access the information, and, therefore, these pathways can become weakened and eventually die out, causing them to potentially lose the information from memory (Ebbinghaus, 1885; Schachter, 1999; Wimber et al., 2015). This may lead to quicker memory decay because mental fitness could be compromised (Shors et al., 2012).

Another important implication to the findings of this study could be that by relying on the Internet as an external source of memory (Clark & Chalmers, 1998; Menary, 2010) and not having access to this memory unless through the Internet, we will not be able to use this information effectively. It is nearly impossible to have higher order cognitions about information that one does not have in memory (Nestojko et al., 2013). Important life skills such as problem solving and critical thinking could be compromised significantly.

There were some limitations to this study. There may have been significant differences between all three groups if the sample size was larger. A continuation of the study would prove useful in determining where differences lie and how strong the effects are. The small sample size may have affected the significance of the correlations as well.

Another limitation may be that since people are constantly connected, there may be a constant prime for Google searching. The population always have their smartphones nearby and know they are available to use to search the Internet at any time. Several participants reported that while they were taking the general knowledge test they wanted to search for answers. This may have led all groups to be primed to search for answers rather than use their memory even without the computer present. Finding a way to fully eliminate the Internet searching prime may be impossible.

The general knowledge test itself may also have been a prime, impacting the results. In the study by Sparrow et al. (2011), they found that when an answer is unknown, people tend to think of computers, and when thinking of knowledge in general, thoughts of computers may be primed. Simply by taking a general knowledge test and not knowing an answer, participants were likely primed to think of Internet searching even in the control group. The constant availability of the Internet on people's phones, the presence of the general knowledge test and the unknown answers all help explain why there was no difference between the control and the "no Google" groups.

It is also significant to note that there were no correlations between the frequency of Internet or Google usage and the number of unknown answers to questions. It appears that the frequency of Internet and Google usage is not related to whether people know the general knowledge questions. This could perhaps be explained by the fact that most people in the study reported relatively high frequency of use. Thus, the lack of variance made it difficult to find any correlation (see Results). All participants seemed to be constantly connected, but perhaps a larger age range or more varied population in the study would yield a relationship.

Another possible topic for future research would be whether results are similar if people use their own phones for looking up unknown answers rather than a computer. People typically use their smart phones to search Google throughout the day, instead of waiting until they get to a computer, so perhaps using a personal Smartphone would be an even stronger prime. This could also be true for the "no Google" group. If participants have their phone next to them on the table while taking the general knowledge test, that may also have a stronger blocking effect than the computer did.

A more effective way to test the amount of blocking and the effort of retrieval may be to time participants when they take the general knowledge test. The participants who could not use Google perhaps found ways to reduce blocking and therefore performed as well on the general knowledge test as the control group, but it may have taken them longer to complete the test because they had to put in more effort to retrieve the information. Timing the participants can be implemented in future research.

Knowing the results and potential implications of this study, there are some actions that need to be taken. One area for future research is to look at the long-term effects of Internet searching. Specifically, researchers will need to look at whether it is related to worse cognitive functioning, such as less efficient or impaired problem solving and critical thinking, and quicker memory decay. In the meantime, a couple actions can be taken to combat potential effects. First, people can try harder to retrieve information from memory before turning to the Internet. It may take more effort, but it is important to keep those pathways strong. However, if Internet searching is necessary, more effort can be put into encoding the important information that is searched, so it can be accessed through memory later, rather than having to look it up again. Hopefully in the end, we will find that the Internet provides more than it takes.

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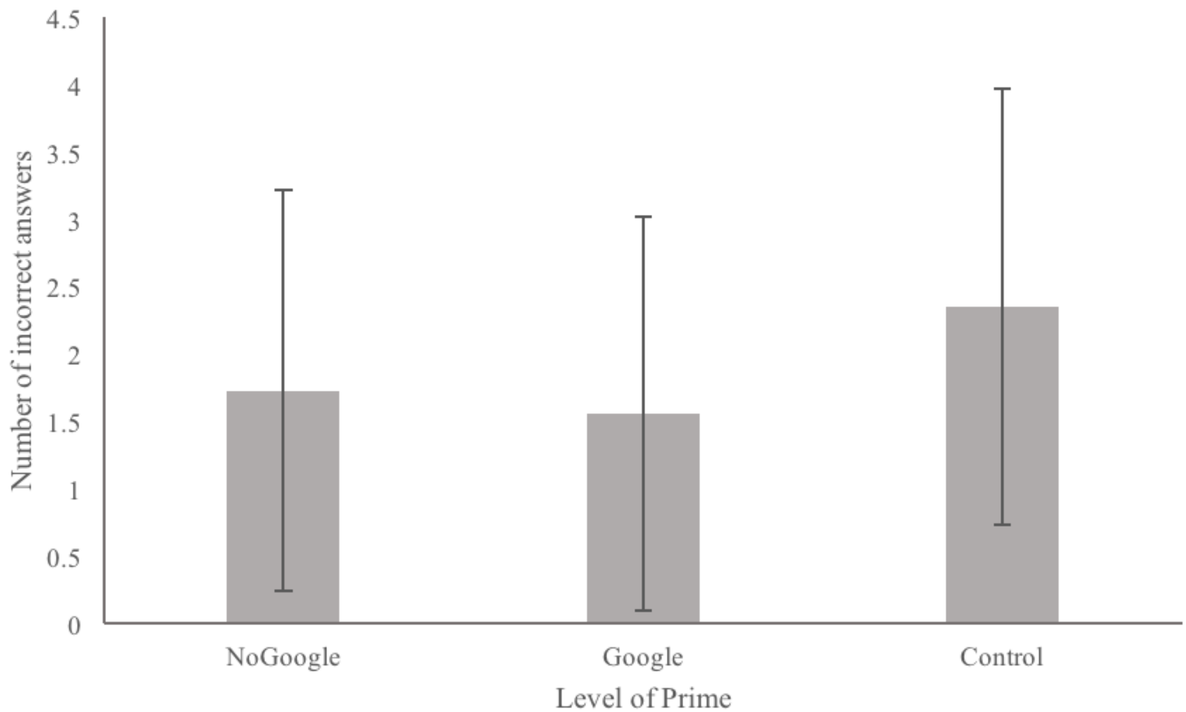

Figure 1. Comparison between the likelihood of a person to intervene positively and negatively.

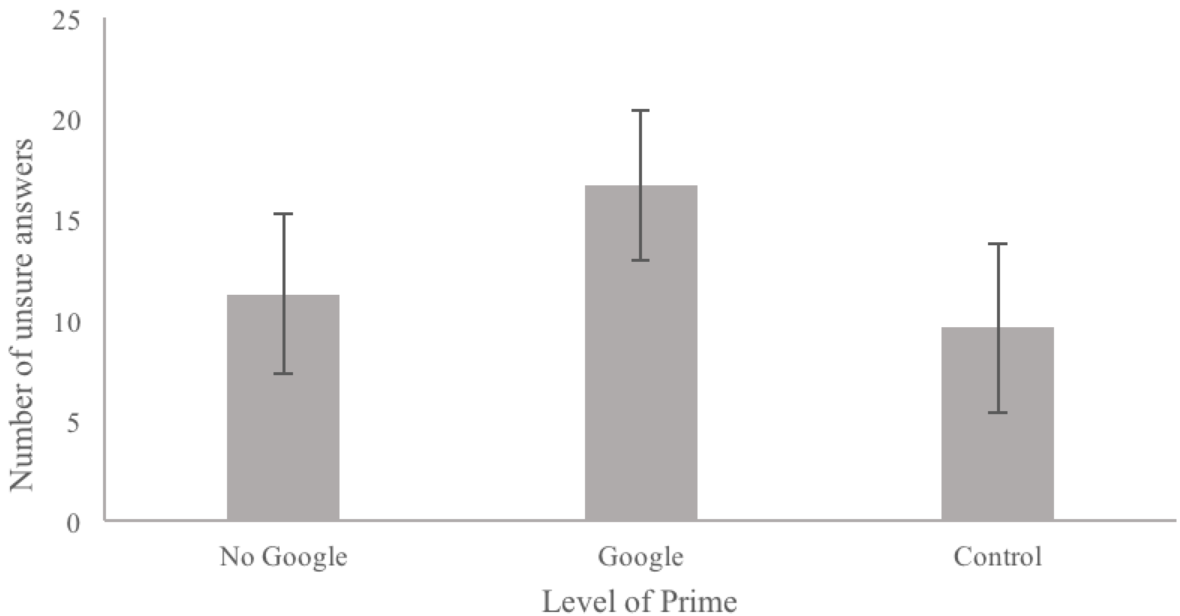

Figure 2. The effect of the level of prime on the number of unsure answers.