Title
Pushing the Boundaries of the Google Effect: The Effects of Reliability and Familiarity on Offloading

Author
Schooler, Joel Nathaniel

Publication Date
2020

UNIVERSITY OF CALIFORNIA SANTA CRUZ

Pushing the Boundaries of the Google Effect: The Effects of Reliability and Familiarity on Offloading

A dissertation submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY in

PSYCHOLOGY

by

Joel Nathaniel Schooler

September 2020

The Dissertation of Joel Nathaniel Schooler is approved:

Associate Professor, Benjamin Storm, Chair

Professor Stephen Whittaker

Professor Alan Kawamoto

Quentin Williams
Interim Vice Provost and Dean of Graduate Studies.

Table of Contents

List of Figures

Abstract

Pushing the Boundaries of the Google Effect: The Effects of Reliability and Familiarity on Offloading

Joel N. Schooler

Prior research has shown that people have a better memory for facts when the fact is deleted from a computer, rather than saved. The current understanding is that we are offloading items that are saved and thus have no need to remember them. The question that remains is if there are any limitations to this phenomenon. We conducted two different experiments to explore these limits. Our first experiment looked at how the reliability of the saving system affected memory. We found a significant interaction effect that shows that this offloading effect only occurs on reliable saving systems. In experiment two, we looked at the effect of familiarity with specific topics on the offloading effect. We found that there was no interaction between familiarity and saved status. However, we did find evidence of a topic status interaction. This means that some topics were more effected by the topic type than others. These studies suggest that future experiments in the transactive memory domain need to take into account the confidence in the offloading partner and the topics that are chosen as stimuli.

Acknowledgements

The research in this paper could not have been accomplished alone. Scientific endeavors are built on the discoverers of the past. It has been said: “That if I see further now, it is because I stand on the shoulders of giants.” This work relies heavily on the work of Betsy Sparrow, Jenny Liu, and the late Daniel Wegner. I would also like to thank Kiuyan Hone for graciously corresponding with me about some of their work.

I would like to thank my advisors Benjamin Storm and Steve Whittaker for their devotion and mentorship. I learned a lot, and also grew as a scholar and person. Having been in two labs I learned a lot about different science worlds be they industry or academic. I have learned so much from the two of you and am forever thankful.

Second, I would like to my dissertation committee: Alan Kawamoto, Steve Whittaker, and Benjamin Storm. Your comments, patience, and mentorship were very important. I would also like to thank the faculty and staff for their dedication to the science. —Doug, thank you for all of your support in stats. I am thankful for my cognitive cohort — Trevor. I am also forever grateful to Erik Nilsen, Diana Leonard, and Timothy Linehan for their support in my undergrad getting me here.

I am especially grateful for the support of my fellow collogues and friends I made in the department. A huge special thanks to Patrawat for her mentorship. Another thanks to Sean Stone for his comments and discussions. I am thankful for lab mates Charlotte, Jeff, Victoria, Artie, Kelsey, Julia, and Chris. I am grateful for all of the friends I made along the way as well: Sam, Christy, Allison, and many others. My friends Duncan and the others in Victoria gave me the perfect escape every year. And to Abe, who gave me a philosophical perspective. I would also like to thank Lauren and Makenzie for their comments.

I am also thankful to the many people who conducted this research with me. My research assistants: Kristen, Philip, Delaney, Camile, Katy, Max, Abby, Aaron, Rilee, Kathryn , Ava, Alysha, Francesca, Sarah, Nick, Jeremy and Caroline.

A special thank you to my family. I dedicate this dissertation to all of you. Mom- thank you for everything, thank you for all of the words of advice and wisdom. Finn- Thank you for always checking in, and yes, I am in good standing. Dad- Thank you for your support and also for teaching me what graduate school would be like, it made the road so much better. I also need to thank my grandparents: Nina- Thank you for all of the support and sound research advice and Mimi- For your encouragement . With a special note to my grandfather Carmi who passed away during my fourth year here. It is no secret that my family is ingrained in Psychology, but he perhaps started it all. To my uncle Lael and aunt Julia, thank you specifically for the help with statistical problems. Aunt Angie and Uncle Clay, thank you for many nonpsychology discussions. And my sister Rachel, thank you for always being there for me.

I would like to express my deep gratitude for my partner Mikaela. Your emotional support, humor, companionship made this so much easier. I am forever thankful to you. This research would have been impossible without you.

Pushing the Boundaries of the Google Effect: The Effects of Reliability and Familiarity on Offloading

Introduction

The value of remembering has been debated since antiquity. Around 370 BCE Socrates argued that writing things down into wax tablets would destroy the art of memory (Plato, Phaedrus 274e-275a). Socrates argued that there is an ineffable quality to memory, that makes it bond to the soul of a person, and that when written, something is lost. This feeling is still present in many today, as evidenced by the numerous ways people challenge memory aids.

Einstein, for example, had a different approach to the memory debate. Einstein was once asked what the speed of sound was, and replied, "[I do not] carry such information in my mind since it is readily available in books." ("Edison Test," 1921). Einstein here is showing us that there is importance to processing information that can outweigh simply knowing information. Socrates and Einstein's differing perspective on the value of remembering things epitomizes an important current debate: how does technology change the way we remember things? Furthermore, is something lost when we rely on things that are outside of our heads?

This debate has entered popular culture and is often associated with the question of whether technology is destroying people's minds (Conover, 2016). There are many facets to this debate; there are those who argue that organic memory is superior and should be encouraged. Some argue that it is not necessary to remember everything; that instead, we should work on processing ideas as Einstein pointed out. One example of this debate can be shown with the question if kids should learn times tables if calculators are available. The debate has been observed in the workplace and schools as people have access to ways to consume information (Yacci & Rozanski, 2012).

One of the problems that comes with having information at our fingertips is that people inflate what they think they know (Ferguson, Mclean, & Risko, 2015). When people use the internet, they will be more likely to use the internet again for future knowledge (Storm, Stone, and Benjamin, 2017).

For this dissertation, I will be discussing the differences between biological and external memory. I will then be giving a brief overview of the transactive memory field and the rise of the Google Effect phenomenon. I will then explain why there is a reason to explore the limitations of the Google Effect.

Biological memory

According to many psychologists, memory is the storing of events in one's brain or mind (Ebbinghaus,1913; Neath & Surprenant, 2007; Schacter, Gilbert, Wegner, 2009; Baddeley & Eysenck & Anderson, 2009). People tend to value their internal biological memory. Thus, people are aware of things that might harm their memory (Belluz et al., 2018).

Biological memory comprises two categories (Tulving & Schacter, 1995): Declarative and Non-Declarative memory. Declarative memory is further broken down into semantic, episodic, autobiographical, and spatial. For this dissertation, we will be focusing on semantic memory. Semantic memory is the memory for facts and things (Collins & Loftus, 1975). Semantic memory is the type of memory that is often thought of as being particularly valuable, and the one subject to destruction by technology. We can contrast this type of memory with episodic memory, or memory that corresponds to specific events we can typically recall in a story form (Tulving & Thomson, 1973). The other type of memory that we need to contrast with is spatial memory. Spatial memory is the type of memory that allows us to remember where things are and how to find them. In general, these types of memory are all interconnected.

In most cases, when people learn something, memory is transferred from short term memory to long term memory (Baddeley et al., 2009). This type of memory usually can be recalled in total isolation. However, once a memory is recalled, it must be reconsolidated (Dudai & Edelson, 2016; Hardt, Einarsson, and Nader, 2010). The reconsolidation means that the original memory is subject to change each time it is recalled. Therefore, the memories that are recalled are not the original memories that were encoded. All memories are susceptible to the context in which they are recalled. The susceptibility to change can be interpreted to mean that biological memory is fallible (Schacter, 2001). This susceptibility means that logically, we should not always put too much trust in what we can recall. Eyewitness memory is especially vulnerable to manipulation and failures (Loftus and Palmer, 1974). Given this, people often try to find ways to strengthen their memory.

External Memory

To combat memories being changed in the brain, people will store memories in the environment or other people (Wegner, Erber, & Raymond, 1991; Clark and Chalmers, 1997; Clark 2008; Barr, Pennycook, Stolz, & Fugelsang, 2015). Offloading is the phenomenon of using other people and things to externalize memory. Risko and Gilbert (2016) define offloading as "the use of physical (or mental) action to alter the information processing requirements of a task to reduce cognitive demand" (p. 676).

Language and writing are the most common means of passing on ideas and storing information. We utilize such linguistic methods to both benefit ourselves and others. When we include others, we create a system that some have called the 'group mind' (Rousseau, 1767). The group mind is the collective knowledge a group has. Each member contributes some form of knowledge or memory that not every other member has. This means that as a collective, the group knows more information than any individual does. The group mind allows for specialization, and not everyone needs to know everything at the same time. The manner in which people exchange information can be said to be transactional.

Transactive Memory

Wegner (1987) formally described transactive memory as "a shared system for encoding, storing, and retrieving information." Wegner (1995) proposed that the transactive memory system (TMS) is like a computer network. It consists of directory updating, information allocation, and retrieval coordination.

The first element of Wegner's TMS Model is directory updating. Directory updating is where we create a mental representation of the location of an offloaded memory. Both the creation and updating of a directory are included in this step. Directory updating involves metamemory information concerning the contents of other people's minds (Hu, Luo, & Fleming, 2019; Dunn & Risko, 2015; Nelson, 1990). However, TMS is concerned with perceived rather than actual knowledge of expertise (Hollingshead, 2000), i.e. these meta memories or metamemory judgments do not have to be accurate just believed. They can be based, and often are, on stereotypes (Hollingshead & Fraidin, 2003). Furthermore, these judgments do not necessarily require verbal communication and can be formed using nonverbal cues (Hollingshead, 1998). That said, verbal communication can aid the construction of transactive memory (Hollingshead & Brandon, 2003).This system updates when information about the storage person changes. For example, if a person just completed a course, in the future they might be considered more useful for that information pertaining to the course.

The second element is information allocation, which involves decisions about assigning information to be remembered to other members in the group or oneself. Information allocation is where we gain information and allocate it to the person to whom will store it. This process means that once we are aware of information, we need to decide if we want to keep the memory organically or ask someone else to keep it.

Lastly, retrieval coordination is planning how to retrieve information items in the most efficient way based on who knows what. Retrieval coordination is where we decide to access information that we stored. We can remember that we stored a particular piece of information with that person. We also know not to go to a person whom we know does not have that information.

Studies on offloading and transactive memory

Storm and Stone (2015) showed that when we offload an item, we increase the memory for non-offloaded items. This study also showed that trust was an important factor. When participants did not trust the saving system, there was no boost for non-offloaded items. However, Whittaker, 2011 argued that when we offload personally relevant items, we do not forget them. Personally relevant items often include family events, names of family members, where you live, etc. The difference between personally relevant information and non-personal info can come down to integration and differentiation. Differentiation is where information is spread out amongst individuals, and integration is known to all members (Gupta and Hollingshead, 2010). Personal information is integrated into both the person and the transactive agent. Whereas, facts are assigned to different agents based on specialty. The distinction means that personal information is offloaded only to serve as a cue for memory and not storage of the memory. However, the cuing of facts is not needed as a person knows that the agent's responsibility was to store the fact.

Furthermore, if we can remember something, we will (Kalnikaité and Whittaker, 2007, 2011, 2012). In other words, Kalnikaité and Whittaker found that offloading will not always decrease memory. Their finding also alludes to the balance of trust in retrievability being a key factor. Their study had participants offload either verbatim, verbatim with a time stamped retrieval aid. They found that preference for what they called prosthetic memory, offloaded memory on physical devices, was higher for items that aided in the retrieval process than pure verbatim records. Put simply, people care about ease of access over accuracy.

Taking photos has also been shown to cause a memory loss for offloaded items (Henkel, 2013; Soares and Storm, 2018. They found that this effect is not solely due to an offloading type effect. This finding raises the question of what type of purpose taking photos serves.

Mechanically the process of retrieving digitally saved memories is spatial. Benn et al., 2015 found that we are using spatial navigational and memory regions of the brain, namely the parahippocampal gyrus.

The Google Effect

Sparrow, Liu, and Wegner (2011) explored the applications of transactive memory on computers. They conducted four experiments. The first experiment looked at the association between trivia questions and search engines. They found that people will associate search engines when they encounter information they don’t know. The second experiment compared two groups of people. Half of the participants believed that they would have access to saved facts later, the other half believed the facts would be deleted. Participants then saw forty trivia statements. Half of the participants were told they needed to remember the statements; the other half was not. There was no effect on the extra reminder to remember statements, However, they did find that participants recalled information better that they believed they would not have access to in the future. Experiment three showed similar results but with a within-subject design and recognition tasks instead of free recall. Participants were given the expectation that they could access the trivia statements by giving them access during a practice trial. Experiment four had all statements offloaded and then compared the free recall of the statements to the recognition of the location a statement was saved in. They found that the participant's recall was better for the folder location than the actual memory for the statements itself. The general summary of their experiments is that participants have a better memory for items that can only be recalled via organic memory than saved on the computer, or readily findable online when they are needed.

Sparrow et al. (2011) claimed that their finding matched the Bjork & Bjork, 1992 finding that if we do not think we need information, we will not remember it as well as if we think we need it. In other words, by the nature of a fact being offloaded, we do not think we need it.

In a mass replication study, researchers failed to replicate the first experiment in Sparrow et al. (2011). This failure brings into question the validity of other results in the same study (Cramer et al., 2018). There have also been other failed replications of Sparrow et al.(2011).

First there was a study conducted by Chu(2015). In this study participants had two different types of facts, easy and hard. Participants then had those facts either deleted, saved, or unreliably saved. In the unreliable save condition information was only actually saved part of the time. Participants before their practice they had the opportunity to restudy saved facts and the saved unreliably saved items. They were not given the opportunity to use the saved facts during the recall test. This is a difference between Sparrow et al.(2011). If participants did not have access to facts during retrieval then they have no reason to offload, as they will have to remember those items in the future anyway.

Could the simple difference in retrieval practice lead to the failure to replicate the study? It is very possible that participants in these replications did not believe the manipulations. How many file drawer studies did this same procedure? A study by Marsh and Rajaram(2018) also failed to replicate this study. The file drawer phenomena, along with Chu(2015), brings in the need to find the boundary conditions of the Google Effect.

In this paper, Google effect refers to the tradeoff of remembering fewer items that are offloaded than items that we believe we need to remember later. In our study, we ask why the Google Effect works in some cases, but not in others? If our study does not replicate, does this mean that we are not treating computers as offloading agents? What process is going on when we save items on computers? It seems clear that people enter information onto computers for a reason.

Understanding the limitations of the Google Effect and offloading will allow us to understand the difference between offloading onto a machine and offloading onto another human. From an applied perspective, this means we will better be able to make machines save information naturally. To do this, we will need to look at credibility (Experiment 1) and Familiarity (Experiment 2). We have chosen these two factors as they seem the most likely to interact with the Google Effect. First, credibility is a requirement in the transactive memory model (Wegner, 1987). The principle of credibility in the transactive memory model states that we will only offload to people we deem credible enough to remember the information we want them to. The question remains if we treat computers with the same regard.

The other factor we are testing is familiarity. Familiarity is also a likely limitation to the Google Effect. If we can form semantic links to facts, we should be able to remember them better (Collins & Loftus, 1975). The question is if there is an interaction between familiarity and offloading. If you are highly familiar with a topic, you would consider yourself to be a topic matter expert. By having familiarity, it is unlikely that you would engage in offloading, as the point of offloading is the allocation of material to the proper repositories. However, with unfamiliar facts, you would need to assume the computer is the topic matter expert and thus rely on it to store information. Accordingly, we would expect to see transactive memory occur w less familiar facts but not with highly familiar facts.

This dissertation attempts to address the ambiguities of when we should expect the Google Effect to occur, and when we should expect to find other factors playing a significant role. This dissertation will also address how robust and generalizable the google effect really is. Finally, it will add to the literature either support for or against the notion that we are treating computers as actual transactive agents.

Experiment 1

The Google Effect argument can be restated to be; if we know we will not have access to information, we will attempt to encode that memory organically. This definition means that knowing future availability is very important as it will affect whether we offload. If we do not trust that we can access the information later, we will be more likely to remember it. Credibility would be a determining factor in if we attempt to learn the information. Our first experiment will look at how increasing or decreasing the level of credibility affects the Google Effect.

Transactive memory requires credibility (Wegner, 1987; Lewis, 2003). We know that in general, trust is needed to build a transactive network (Ashleigh, & Prichard, 2011). This requirement of trust means that we must believe the system or person we are offloading onto is reliable and accessible when we need to engage in retrieval. If people do not have access later to it, or at least an appearance of such, they will attempt to remember it organically. This choice is due to people making decisions that limit loss (Tversky & Kahneman, 1991). Conversely, if we have strong trust and confidence in our ability to retrieve information reliably, and more efficiently than we can remember it organically, we will offload it.

Experiment 1 examines how credibility vis-a-vis reliability and trust affect offloading. Credibility in this study is how much a participant believes they will have access to the information so that computer retrieval is possible.

A highly credible and reliable offloading partner should yield more "efficient" offloading (Lewis, 2003; Weis & Wiese, 2018). Wegner (1987) explained that when someone believes someone is good at remembering something, they will tell that person that type of information, and then forget it so they (the offloader) can remember other information. Kalnikaité and Whittaker (2007) showed that when comparing pen and paper, to record, to time-stamped record notes, people would offload more efficiently when given the time-stamped recorded notes. This finding is attributed to accessibility, as participants could quickly find information based on key phrases. This finding was also attributed to participants having a greater sense of future accessibility when encoding. In all previous studies, the offloading system has been claimed to be credible when it is saving. This observation leads to the question of what happens when there is a change in how credible the saving system is? When participants do not trust a computer to store saved information, do they put more effort into remembering?

Computer credibility is dependent on multiple factors. All of these factors, however, affect each other. For example, if a computer crashed running one program, you would assume it might crash running another. This experience means that there is a transference of error on computers. Merely making the computer look slow is enough to make you think it is less reliable (Fogg & Tseng, 1999).

Understanding if people's judgments of trust in computers influence their ability to offload is essential. It allows us to connect the credibility requirement of people-centered transactive memory to computers. Positive results from this study would yield evidence that transactive memory in people is the same system as that involved with computers. However, if we find that trust is irrelevant in computers, then a different mechanism is at play. That is to say that transactive memory in people is different than in computers. Such a finding would mean that we are not treating the computer as members of a connected network of transactive partners.

Experiment 1 will test the effect of credibility on the google effect. We will vary whether participants get a practice condition that maintains expectation in the ability for future retrieval (Reliable), and one that is designed to disrupt the credibility of the computer (Unreliable). We predict that participants will experience the google effect; namely, they will remember more deleted items than saved in a reliable condition. However, in the unreliable condition, participants should not experience the google effect.

Participants

Eighty participants from the University of California Santa Cruz were recruited to participate in this study for course credit. This number was chosen based on the results of Sparrow et al.(2011) with a power calculation of .8. Participants were recruited from the university's research participant pool. All participants were enrolled in a psychology course at the time. The series of studies were run in 2018 including December. It should also be noted that during the time and running of this study, in person studies were run.

Materials

In this study, we used the materials initially developed by Sparrow et al. (2011). We chose to use the same facts to maintain validity for our replication and extension. From the master fact list that Sparrow et al. made, we chose fifteen facts to be the practice test facts and the remaining ones for the main phase of the experiment. For the practice trials, we chose facts 31-40 from Sparrow et al. We also generated five facts to bring the practice trial to 15 facts. The generated facts were written in such a way that they matched the style of the other practice facts. Furthermore, the recall of these facts would not be analyzed as participants had access to them during practice recall. Facts for the main phase of the experiment were pulled from Sparrow et al. (2011), facts 1-30.

The program for the practice phase was designed to present facts in random order and randomly determine if a fact presented was to be saved or deleted. Once the program had completed presenting all facts, the program would randomly determine whether it would be reliable or unreliable. If the program was reliable, it would produce a save file containing all of the saved facts in a CSV file format. If the program was unreliable, it would pop up an error message (Figure 6 in appendix). For the main phase, the same program was used but would present the 30 main phase facts. However, this program was always set to be unreliable.

All participants in this experiment were on a Mac computer in a sealed room without windows. Lights were at full brightness, and participants used a standard mouse and keyboard. The background was set to grey.

Procedure

Participants were told that they would be in a study that involved memory and computers. We told the participants that the computer would save some facts, and delete other facts and that there would be a memory test. At the start and finish of the study, we told participants that they could use the saved facts to help them recall. Participants were then introduced to the computer program that would be presenting facts sequentially and informing them (at the top of the screen) if a fact was to be saved (see Figure 3 in appendix) or deleted (See Figure 2 in appendix).

Practice Phase

Participants were randomly assigned to one of two conditions (Reliable Practice or Unreliable Practice.) In both conditions, participants were presented with a series of 15 facts presented in random but sequential order. That is, one fact followed another, one at a time. When a new fact was presented, participants were told if it was to be saved or deleted (See appendix 4). We instructed participants to type every fact that they saw. The participant then pressed the return key to save or delete the fact as the program said. After completing all fifteen facts, the participant hit enter one more time to save the facts the system said it would save to the desktop.

For participants in the reliable condition, the computer saved a file called “Facts_For_You.txt” onto the desktop. This file contained all of the saved facts and none of the deleted facts. In the unreliable condition, an error message would appear at the end: “Unable to save files: Data Corrupted” (See appendix 4).

After seeing the error message or the saved file, participants played the game 2048. Participants played this game for five minutes before being asked to open up a recall application to engage in a free recall task for ten minutes. These times were chosen based on prior research showing no benefit from longer delays(Skags,1928; Wang, 2014). In the reliable-condition, participants were allowed to copy and paste facts from the saved file to the recall program. Participants in the unreliable condition were told that they had to recall all fifteen facts.

Experimental Phase

After completing the practice part of the experiment, participants now did a similar task with thirty facts. The program presented facts in a randomly generated sequential order. Each fact was also randomly saved or deleted using a java randomization program. If the computer deleted a fact, it would say, "the following statement will be deleted" (see appendix 1). When the computer saved a fact, the computer displayed the following message: "the following statement will be saved." We instructed participants to type each statement and then press the enter key. After completing all thirty facts, participants again pressed the return key. This time the error message from the unreliable condition appeared(See appendix 4).

After viewing the message, the participants played the game 2048 again for 5 minutes. Participants then opened up the free recall application. We told participants they had ten minutes to recall all thirty facts via free recall. We debriefed participants after completing the free recall task.

We coded the statements that the participants recalled in a manner similar to Sparrow, Liu, and Wegner (2011). Our raters judged the statements based on correctness. Raters were blind to the condition (reliable or unreliable) the participant was in. If the participant recalled the statement verbatim, they would get one point, if they recalled the statement entirely correctly, but not verbatim, they also got the point. However, if there was information missing, they would only get .5 points, and if they did not recall or recalled less than half of the statement, they would not get any points.

Results

We ran a 2 (Practice Condition: Reliable vs. Unreliable) x 2 (Item Type: Saved, Deleted) repeated measure ANOVA to test the hypothesis that people would remember more items when they were not saved, than saved.

We found that people remembered more deleted facts ($M=27.4$, $SE=1.8$) than saved facts ($M=20.4$, $SE=1.7$), 95% CI [2.3,11.6], F (1,78) =9.273, p = .003, ,$\eta_p^2=.106$.

We did not find a main effect for the between subjects' condition of reliability (reliable, unreliable), 95% CI [-1.2, 9.4], F (1,78) = 2.34, p = .13, ,$\eta_p^2=.029$.

We also found an interaction effect for recall status and reliability condition, F (1,78) = 24.11, $p < .001$, ,$\eta_p^2=.236$.

We found, using a paired samples t-test, using a Bonferroni adjustment that participants in the unreliable condition did not differ between saved($M=24.03$,$SD=14.13$) and not saved facts($M=19.73$,$SD=11.904$), We are 95% confident that the difference between reliable and unreliable practice is between -1.8% and 10%. CI(98)[-1.8,10], $t(41) = 1.688$,p = 0.09. $d=.32$.

We also found that in the reliable not-saved ($M=35.12$,$SD=20.10$) condition participant recalled with 98% confidence between 7% and 25% more facts than the saved condition($M=16.77$,$SD=16.05$), CI(98) [.08,.27] , $t(37) = 4.674$,$p < .001$,$d=1.02$.

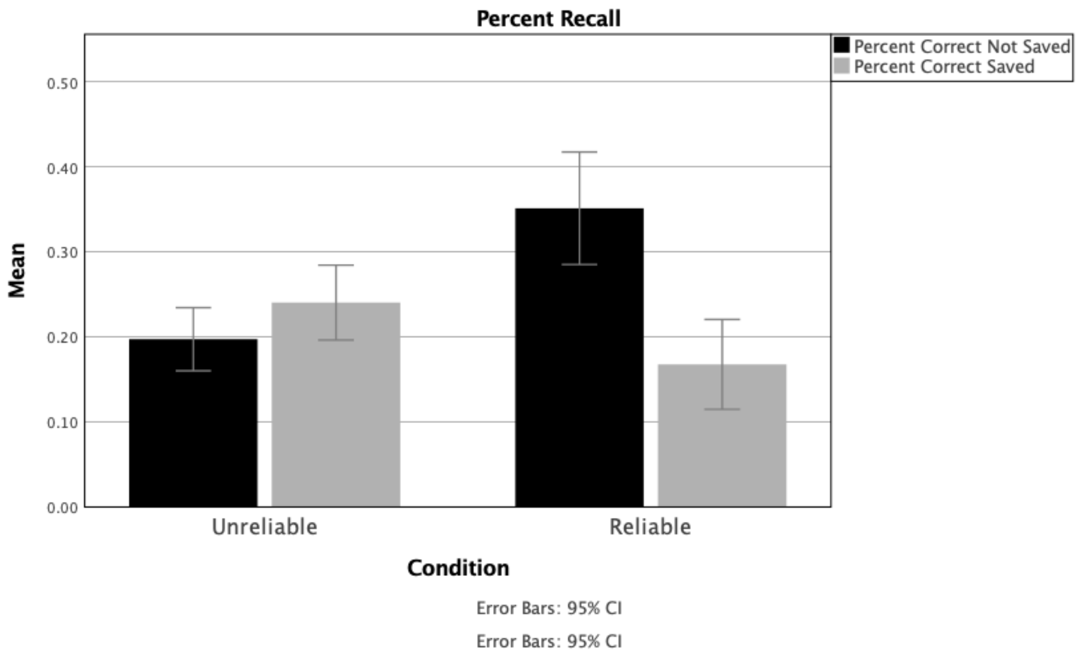


Figure 1: Participants showed the Google Effect in the reliable condition but did not show this effect in the unreliable condition.

Discussion

These results indicate that the reliability of future perceived retrievability drives the Google Effect. This finding suggests that lack of trust may drive failures to replicate, and that trust may drives offloading. This distrust may not be overt. Perhaps simply denying the ability to access saved files at recall creates distrust. This explanation suggests that when people's trust in the computer's save-system is violated, they will not offload. They are likely making a loss aversion decision in this case. Furthermore, when we have good evidence to believe that we will have access to information in the future, we will offload.

Traditionally with organic offloading or transactive memory, people offload more efficiently when they trust their partner's ability to remember specific facts (Wegner et al. 1991). This trust factor directly translates into how we offload with computers based on the evidence we found. This discovery means that Transactive Memory in humans is a very similar process to that of computers. We are likely not considering the computer in this case as another agent, but rather as a partner. This partner's job is to remember items that we do not need to remember. This relationship means that if we find fault with our partner, we will not attempt to convey information that we knowingly know will be lost when we go to retrieve it.

Knowing about ease of access is a significant factor in offloading (Kalnikaité and Whittaker, 2007). This factor shows that believability in ease of access is essential. In experiment 1 , we know that we will have access to files when we need them most. However, when that trust is disrupted, we don't see the Google Effect. The manipulation changed how participants perceived future access. For every fact in the study, participants were told if a fact would be saved or deleted. What changed was if they trusted if the saved facts would in fact be saved.

In the high-reliability condition, participants had no reason to doubt if they would get the facts during the retrieval. Conversely, participants in the low-reliability condition were shown that the system was unreliable when it generated an error message. This message made them doubt if the system would save the files in the second round. When we distrust the recall system, we will not consider it a transactive partner and will attempt to remember facts and disregard the status. We can support this claim by pointing out that there was no difference in the number of facts recalled between groups.

The interaction shows that the way we are allocating what we remember and what we forget, or not encode, varies depending on whether we had a reliable or unreliable transactive partner. If we deem the computer reliable, we will trust that it will give us our saved facts when we need them. Therefore, we have no reason to remember items that are offloaded. While when we have reason to distrust our transactive partner, we will not engage in such behavior. The considerable effect size also backs this interaction.

Experiment 2

Based on the results of experiment 1, we determined that a trustworthy computer should be used for encoding and retrieving all participant's facts. Nevertheless, a question remained about how familiarity with facts would affect the ability to recall them when participants were in an offloading situation. Facts that are familiar to a person should be more self-relevant than those that are not and thus remembered better (Klein & Loftus, 1988). A critique that can be made of the original Sparrow et al. study is that participants might do better on facts they are familiar with than those they are not. In particular, if we are already learning about a material of interest, we would not have a need to offload it. To address this criticism, we piloted participants about what topics they knew about during experiment 1 and used it to generate ten topics that would be used for experiment 2.

This study expands on the results of experiment 1 and uses the reliable manipulation condition as its primary way of maintaining saved information. Namely, participants always had access to facts during the practice phase of the experiment.

Experiment 2 had participants rate their familiarity in 10 different topics. Participants then engaged in a practice phase where facts were randomly saved or deleted. Participants then had access to facts that were saved. Following the practice phase, participants engaged in the main experimental phase with facts that were saved or deleted randomly. Finally, they engaged in a retrieval task without the aid of the saved facts. We predicted that there would be an interaction between familiarity and saved status, such that participants recalling familiar facts would experience a difference between saved and unsaved facts, whereas participants recalling unfamiliar facts will see the google effect.

Participants

Eighty-Three participants were recruited from the University of California, Santa Cruz’s research participant pool. This participant count was the maximum number of participants allowed to be recruited during the pandemic due to limited resources. We gave participants instructions on how to attend the study online. Participants were given course credit for their attending the study. This study was run during the 2020 COVID-19 pandemic. We therefore decided to run this study online for the safety of both participants and researchers.

Materials

For this study, we decided that instead of presenting participants with a series of unrelated facts, we would present them with facts related to a particular topic. We will call this Statement Topic. We determined the statement topic by running a survey at the end of experiment 1. We narrowed down common topics to Animals, Movies, Music, Art, TV, Geography, Sports, Food, and Technology. For each of these topics, we generated four statements, for a total of forty facts. We generated four statements following the pattern and style of Sparrow et al. (2011) facts. Each fact was always limited to 1 sentence. For example, “A group of ferrets is called a business.” A small number of the facts were required to include dates and other specific numbers, “The Macintosh was released in January 24th, 1984”. See appendix for a complete list of facts.

We created a master list of facts by randomly selecting thirty facts from the forty facts that we had generated. The practice test used the remaining ten facts. Five additional facts were carried over from experiment one’s practice phase to bring the total practice phase recall to fifteen. All facts within their phase were both presented in random order and randomly saved or deleted.

Procedure

Survey Phase

Participants were recruited on the university participant pool system, and they were instructed to follow a Zoom link where they would meet the experimenter. The experimenter then shared their screen with the participant. The participant was then able to control the screen of the experimenter. The experimenter then showed the participant a survey that consisted of a rank order of ten topics. The participants were told to order the topics on a scale of 1-10, being how familiar they were with them in comparison with the other topics with one being most familiar. They were explicitly told to “Please rank order the following in order of familiarity. 1 is MOST familiar, and 10 is LEAST familiar”. After rank ordering the topics, participants were asked to individually assess how well they knew the topic using a 5-point Likert scale with 1 being the most familiar, and 5 being not familiar at all. Participants were also verbally reminded that 1 was the most familiar variable.

Practice Phase

After completing the survey task, we showed participants the experimental interface. We told participants that the computer would present them with fifteen facts. We told them that they would have access to facts that saved for a later recall test. We then showed participants were on the interface the computer told them the status of a fact. They were then told to type every fact that they saw, and then hit enter.

The computer presented 15 facts to participants. Ten of these facts were based on the ten topics, with one fact per fact, and the other five were unassociated and from experiment 1. The computer system randomly presented the order of these facts and randomly determined if it would be saved or deleted independently of category. After completing all fifteen facts, the computer saves a file to the desktop visibly labeled as factsforyou.txt. This file contained all of the saved facts.

We now told participants that they would be playing the game 2048 for five minutes. After five minutes were up, participants were given a free recall test on the computer. At the beginning of the practice test, participants were told to open the saved file and copy and paste each statement from the saved file into the text box. At the same time, we told participants that they had ten minutes to recall all fifteen facts.

Experimental Phase

After completion of the practice recall phase, participants were then given the interface again, which presented thirty facts. For each fact, the computer randomly decided if the fact would be saved or deleted. At the end of this phase, however, the computer displayed an error message saying that the computer failed to save the facts (Figure 6). The experimenter stated, "well, we still have to continue" and then bring them to 2048 for five minutes. After five minutes we stopped participants and gave them a free recall test on the computer for ten minutes. We told participants that they had ten minutes to recall all thirty facts.

The data were individually coded by correctness by two judges and then averaged. We gave a full point to participants for each fact recalled 100% correctly. This rule, however, includes semantic accuracy. For example, "An ostrich's eye is bigger than its brain" was judged to be equivalent to "The Eye of an ostrich is larger than its brain." Mostly correct recall, includes 50% or more of the target, was scored .5, and non-answers or answers that were less than 50% recalled a 0. This scoring is based on the scoring originally presented in Sparrow, Liu, and Wegner(2011). The raters who scored each fact were blind to each fact's status and rating the participant gave to its category.

We coded participant ranking of topics into High Familiarity and Low Familiarity using a median split.

Results

Our survey showed that participants were on the more familiar side than average for their rating of topics, See Table 1. We also looked at the rank ordering averages, see table 2. It is also important to know how people did on different fact types.

Topic	Animals	Movies	Geography	TV	Music	Science	Food	Art	Tech	Sports
Mean Rating	2.40	2.45	3.5488	2.57	2	2.95	2.09	3.23	2.73	3.52
SD Rating	0.99	0.94	1.11	1.005	0.927	0.96	1.06	1.06	1.08	1.47

Table 1: Shows the mean familiarity rating on a Likert scale of 1 - 5, with 1 being most familiar. 3.5 is the median

Topic	ANIMALS	MOVIES	GEOGRAPHY	TV	MUSIC	SCIENCE	FOOD	ART	TECH	SPORTS
Mean Rating	4.82	5.26	6.23	5.23	4.52	5.80	4.46	6.07	6.02	6.54
SD Rating	2.62	2.64	3.02	2.35	2.80	2.46	2.83	2.93	2.68	3.48

Table 2: Shows the mean rank order position rating for each topic, with 1 being most familiar. 5.5 is the median

To analyze our hypothesis that there was an interaction between familiarity and saved status we broken down our participants responses to their individual familiarity ratings in a number of ways. In our study we had two different scales participants rated familiarity on. The first scale was a rank order scale. Participants rank ordered facts between 1 and 10. The rank order scale was coded in two different ways. The first way was doing a median split on that participants rankings: High Familiarity Saved, High familiarity Deleted, Low Familiarity Saved, Low Familiarity Deleted. The other way was by keeping the data in its raw form. The second scale we used was a 1-5 Likert anchored with 1 being most familiar. In this second scale participants were able to choose any number they wanted for each topic. We then applied a median split to separate the participants into high familiarity and low familiarity based on each participant own rankings with saved status as an addition factor.

Rank Order Effects

We looked at how participants individual rank order of each topic affected their ability to recall facts given the saved status of a fact. For this analysis we compared each participant's own familiarity ranking (High, Low) and saved status (Saved, Deleted) using a repeated measures ANOVA. We found no difference between high familiarity(1-5) facts, and low familiarity facts(6-10), $F(1,81)=.350, p=556$. In this condition we again replicated the Google Effect, and found deleted (M = 36.6, SE = 2.2) items remembered better than offloaded items (M = 16.4, SE = 1.4), $F(1,81) = 64.117$, $p < .001$. Contrary to our hypothesis we did not find an interaction effect, $F(1,81)=.003, p=.960$.

In addition to looking at participant rank order diametrically we also looked at the full spectrum of the rank order itself by participant ratings. Because the experiment randomly assigned the saved status to each fact independently, there were a few instances where a rank order was only not saved, or only saved for some participants. This means that it would be an unfair comparison. Furthermore, given the assumption of ANOVAS “missing” data can’t be used for the comparison. Thus, we settled on using a mixed model analysis on saved status(Saved, Deleted) and the rank order position(1-10). Here we again found an effect for saved status, F (1,1417) =

84.43 , p < .001. There was, however, no main effect for topic ranking, *F* (9.1417) = 1.26 , p = .250. There was also no interaction between status and topic ranking, *F* (9,1417) = .738 , p = .674.

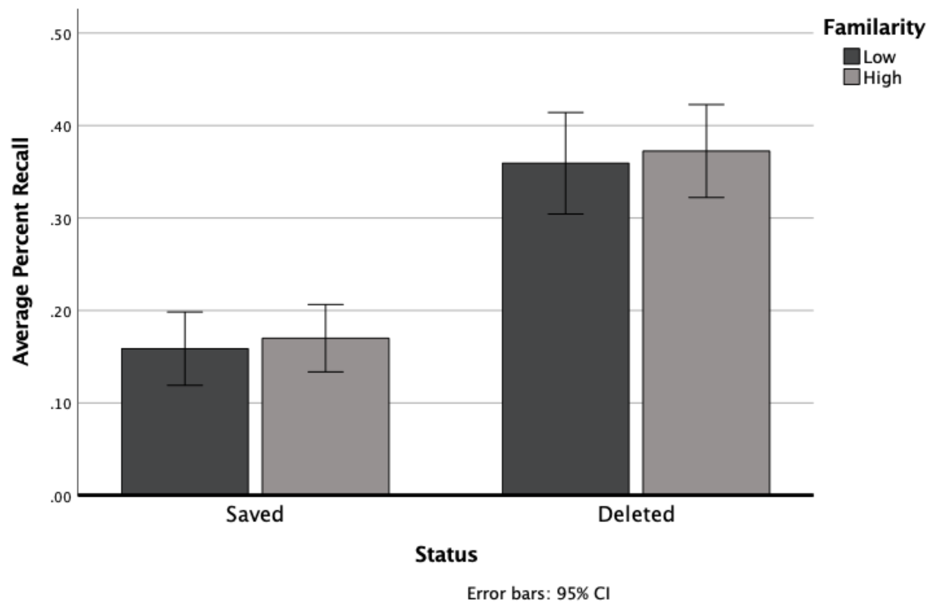


Figure 2: Average percent recall of facts based on participants rank order and saved status

Likert Rating Effects

We ran a repeated measures ANOVA on two within subjects' variables, saved status (Saved, Deleted) and familiarity(High, Low). Familiarity was participants own self ranked familiarity broken into two factors based on their own median. We found no main effect for familiarity, *F* (1,80) = 1.272, p = .263. We found no interaction effect, *F*(1,80) = .263 , p = .871. We did find a main effect for saved status. We found with 95% confidence that participants recalled between 13.2% and 23.9% more deleted facts(M=36.1,*SE*=2.4) than saved facts (M = 17.3,SE = 1.7), 95% CI [13.3,24.4], $F(1,80) = 58.07, p < .001$, $\eta_p^2 = .421$.

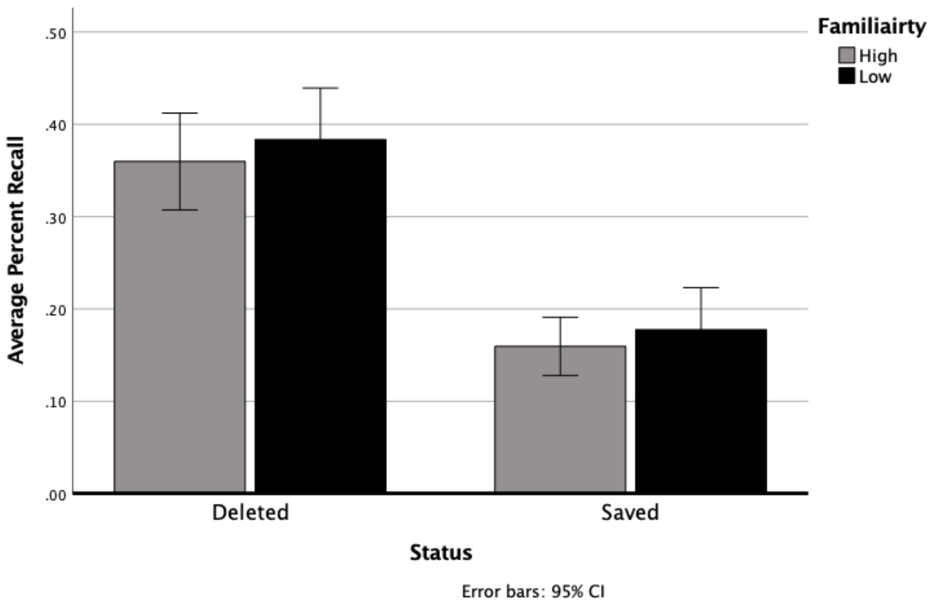


Figure 3: Shows the comparison of Median Familiarity Ranking by Status on the average percent recall.

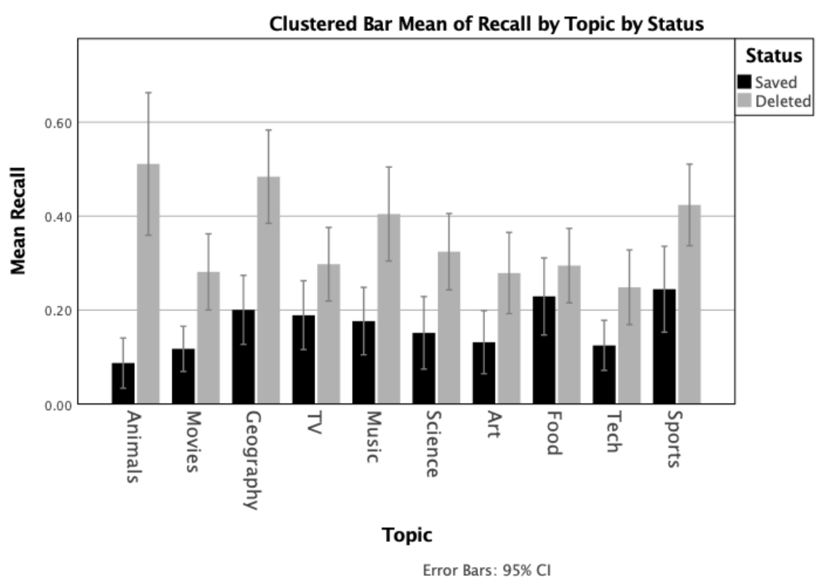
We ran a mixed model repeated measures on participants individual Likert ratings of familiarity(1,2,3,4,5) and saved status(Saved, Deleted). This scale is from 1 to 5, with 1 being most familiar. We again found no main effect for familiarity, $F(4, 642)=1.37$, $p= .242$. There was a main effect for status, participants recalled more deleted items (M=36.4,SE=1.9), than saved items(M=19,SE=1.6), $F(1,642)= 50.861$, $p<.001$, $\eta_p^2 = .378$. There was also no interaction effect between saved status and memory, $F(4,642)=.602$.

Is familiarity correlated with saved status?

We ran a series of ten correlations between topic rating and recall for a given saved status (Saved, Not Saved). We found that there was a significant positive correlation for familiarity of the topic of technology and the recall of technology when it is deleted, p=.026, r(82)=.246. We also found a negative correlation between familiarity with sports and the recall of sports when it is deleted, r(82)=-.293 p=.008. There were no other significant correlations.

Is the topic of the fact affected by saved status?

We ran a mixed effects model on all ten topics by saved status. We treated familiarity as a fixed effected as familiarity is normally static and will not change unless concerted effort is made by the participant. We found a main effect for saved status. Participants recalled between 15.3% and 22.6% more facts in the deleted condition(*M*=35.5,*SE*=1.3) than the saved condition(*M*=16.5,*SE*=1.3), 95% CI[15.3,22.6],*F(1,1428)=103.124, p<.001.* We also found a main effect for topic, *F(9,1428)=3.479.* We also found an interaction between saved status and topic*, F*(9,1428)=3.047,p=.001 (figure



2).

Figure 4 This graph shows the interaction between saved status and topic on the average recall percentage

Pairwise contrasts, with an Bonferroni adjustment, of deleted versus saved facts revealed that there was a significant difference for; Animals , t(91)=5.25, p<.001 95% CI [26.4,58.4]; Movies, t(116)=3.46, 95% CI[7.0,25.7]; Geography, t(126)=4.57, 95% CI [16.1,40.6]; TV(145)=2.02, p=.045, 95% CI[.2,21.5]; Music, t(126)=3.69, p<.001, 95% CI[10.6,35.0]; Science, t(145)=3.07, p=.003, 95% Ci[6.2,28.4]; Art, t(131)=2.68, p=.008, 95% ci[3.9,25.6];Tech, t(117)=2.58,p=.011, 95% Ci [2.9,21.9]; Sports, t(140)=2.83, p=.005, 95% CI[5.4,30.4]. There was no significant difference for Food, t(143)=1.14, p=.254, 95% Ci[-4.8,17.9].

Discussion

These results indicate the Google Effect is replicable with a different series of facts and are not bound to the original Sparrow et al. (2011) material. We also maintained the large effect size from experiment 1. By maintaining the effect size, we demonstrated an important step in showing the generalizability of the effect. Furthermore, we did not find any evidence to support the notion that familiarity with the topic interacts with an offloaded fact. That said, the lack of a main effect for familiarity suggests that either simple facts are not remembered any differently regardless of familiarity, or that for these facts in particular participants did not pay attention to familiarity It is thus a possibility that this manipulation did not work.

We were unable to find an effect of familiarity across a number of different analytic approaches . We tried using a high low split, which did not yield any difference. We also tried this high low split on both individual-level rankings of familiarity and the rank-order level of familiarity. We also found that there was no effect on rank order in general. That is, the level of association between ranks 1-10 did not display any difference.

With all of this said, is there any difference between the topics themselves? We found evidence that topics did differ in how they experienced the Google Effect, but only in a small handful of topics; this was also coupled with an interaction effect.

The interaction we found suggests that fact type may affect the generalizability of the Google Effect. This interaction means that when we attempt to replicate the Google Effect in labs, we need to be cognizant of what facts we are using, as the topic of fact may make a difference if they are all too closely related.

Another possible explanation for why familiarity did not interact with the google effect is that expertise is not equivalent to familiarity. This explanation means we are perceiving the strength of the computer being an expert in remembering is stronger than our ability to use familiarity to the point of irrelevance. We can address a criticism of expertise potentially being assigned, and thus predictive of a lesser effect(Wegner, 1991), by noting that the assumption of expertise is due to what they have seen, not what they are told. Alternatively, participants may just be bad a judging what they are an expert in is based on the topic labels. Lastly, it is also possible the facts did not

Although, in general, null results are inconclusive, we still replicated the google effect on all topics but food. Even in the case of food, the trend was still towards people remembering more deleted items than were saved. These trends and results go a long way to adding to the credibility and generalizability of this effect.

General Discussion

Our studies have shown that the Google Effect is conceptually replicable. Experiment 1 showed that a person's perceived ability to engage in future retrieval from an offloaded source affected their ability to recall organically.   Our second did not find support for familiarity affecting recall or interacting with the saved status, at least when dealing with trivia-style facts. Lastly, we can surmise that the google effect on memory is strong in the right circumstances.

One interpretation of the results from experiment one is that if a person has a reliable saving system, they will not try hard to remember them. Thus, the people are being strategic about what they can remember. This interpretation, however, is not the whole picture. If we are to combine the results from this study with Storm and Stone (2015), that when items are saved there is better memory for new items, we can see that the decrease in the ability to recall saved items is what allows us to remember new items in the future. We are substituting memory for saved items for deleted items.

Experiment 1 expands on the importance of reliability and unreliability in a statement-based context. In the Storm and Stone (2015) study, having facts saved boosted memory for the unsaved facts, but they did not compare the difference between the unsaved facts and saved facts. Those studies show that when we are forgoing remembering saved info, we are allowing ourselves to remember future items. When we have to remember older information, we will do worse in the future.

Experiment 1 should also be contrasted with Storm and Stone(2015) based on methods. In this study, participants were told at the time of presentation the fate of a fact. In Storm and Stone (2015), participants were told after viewing all of the items. In the Storm and Stone paradigm, forgetting was likely driving the future ability to remember, and in ours, is it the lack of encoding items for future recall. That said, it is likely that by not encoding information, the same benefit gained by forgetting is present. By using simultaneous presentation, we create an externally valid way of showing how we offload. We usually decide to offload when creating information(Hu, Luo, & Fleming, 2019).

Offloading is the reallocation of memory resources and is not necessarily simple forgetting. This reallocation could mean that for every item offloaded, a person can organically remember an equal number of items. When we save an item, we are not creating more room for memory, but relocating existing potential room for memory.

Experiment 2 was designed to examine the effect of prior knowledge vis-à-vis familiarity. As mentioned earlier, we did not find any effect of prior knowledge or familiarity measured by the topic on fact retrievability. However, this does not disprove Kalnikaité and Whittaker, 2007, showing that we have a strong memory for personally relevant information. This study used a factoid model for its experiments. Factoids are not personally relevant pieces of information, as they are not participant generated. Future research could also examine the limitations of the Google Effect when dealing with information that is of high emotional salience.

Future studies looking into familiarity could try to use a much larger sample population and use declared major as the familiarity condition. By connecting facts to a person's major, we can better understand when people offload information when it is relevant to a personally chosen expertise. However, at the same time, we need to be mindful that major is not always a good indicator of personal expertise. Therefore, larger sample sizes are needed.

In the transactive memory model, we need to make sure that our memories are offloaded safely to someone to whom the memories are relevant. These results indicate that a similar process is taking place when interacting with computers.

I propose that we are using computers in a similar vein to social agents. This proposition is supported by our finding in experiment one that like in human transactive memory, computers also require trust to offload. Nass, Steuer, and Tauber(1994), postulate that computers are social actors. Given this, it is not that far of a leap to assume that we are applying the same offloading standards that we apply to humans onto our computing devices.

By expanding offloading to computers, we treat them as both parts of ourselves, via extended cognition, and as "others." This should also extend to the internet. In general, anywhere a person goes; they will have access to a large majority of their digital stuff (Bergman & Whittaker, 2016). This is under the assumption that they will have, at a minimum, a data plan. Given the general uptime of most cloud services' reliability, trust in these systems being accessible can be assumed to be high. A possible study could look at levels of internet accessibility and trust in future retrieval.

Offloading onto computers is not something that we need to be ashamed of. It is no different from using other people to offload. The one exception is the possibility of irrelevance and the actual social element. When we engage with the computer, we are treating it as a social agent until we get the information we need; after that, it was simply the storage device. With humans, after we retrieve information, there is a particular social element that remains, we may gain social capital from them, in a certain type of exchange. However, this exchange between humans is what builds trust. A similar mechanism may be at play with computers. Future research should look into how trust is affected after retrieval and what difference may exist between humans and machines in regard to this.

Using the knowledge gained from experiment 1, future studies need to be done on the minimum amount of trust needed to be offloaded. We would predict that it is relatively easy to make people distrust their computers as transactive partners. This relative ease of distrust making would explain the difficulty in replicating the Google Effect. Some of the failed attempts to replicate the Sparrow Et al.(2011) experiment 2 and 3 gave participants the facts to study before(Chu, 2015). Furthermore, for external validity, participants should always be given access to facts during practice retrieval.

Typically, we would expect that people would remember items that they were more familiar with. However, in the case of experiment two, we did not find evidence of this. If we consider when people offload onto others, if someone is an expert on a topic, we will offload to them (Wegner, Erber, & Raymond, 1991). Perhaps, we consider computers to be experts in all topics, making our expertise irrelevant when it comes to offloading decisions.

So far, we have talked about the ways in which saving affects our memory. There are, however, some important personal information management questions(PIM) that arise from these results. Our experiments were laboratory focused. Future PIM studies must address real use cases. We also need to examine the effect of time pressure on saving. In real life people have varying degrees of file organizational structures. They also have to retrieve items under time pressure. We propose that a future study should have participants offload in realistic file save systems, and then vary the amount of time given to retrieve the files. There is likely a relationship between reliability and complexity of save systems. If a file structure is sufficiently complex enough it should become undistinguishable from an unreliable saving source.

Conclusion

Replicating studies is an important facet of science. To discern the difference between a spurious discovery and a real fact, we need to make sure that a finding can be replicated. The Google Effect is no exception to this. In this dissertation, we discovered that there were limitations to the generalizability of the Google Effect in a meaningful way: Credibility affects how we chose to offload. We must be sure that what we offload on can be present when we need it in the future.

This replication is important in the age of the replication crisis. We have shown here that it is possible to replicate the Google Effect, which is the trade-off between deleted items and computer saved items under certain circumstances. In extreme cases, we have shown that if the participant has no reason to believe that the computer will save facts for them and fail to replicate. This realization means that when studying the Google Effect, we must be extra careful to ensure that our methods ensure belief in future retrievability and ease.

Future studies need to address the effect of agency on how we offload. In most previous research, participants were given no real choice if they should make the saving decision. This dissertation shows that the choice to offload is not coupled with the saved status, but rather our trust in the saved status. If we allow participants to control the saved status, we can understand the way we offload more deeply.

Appendix

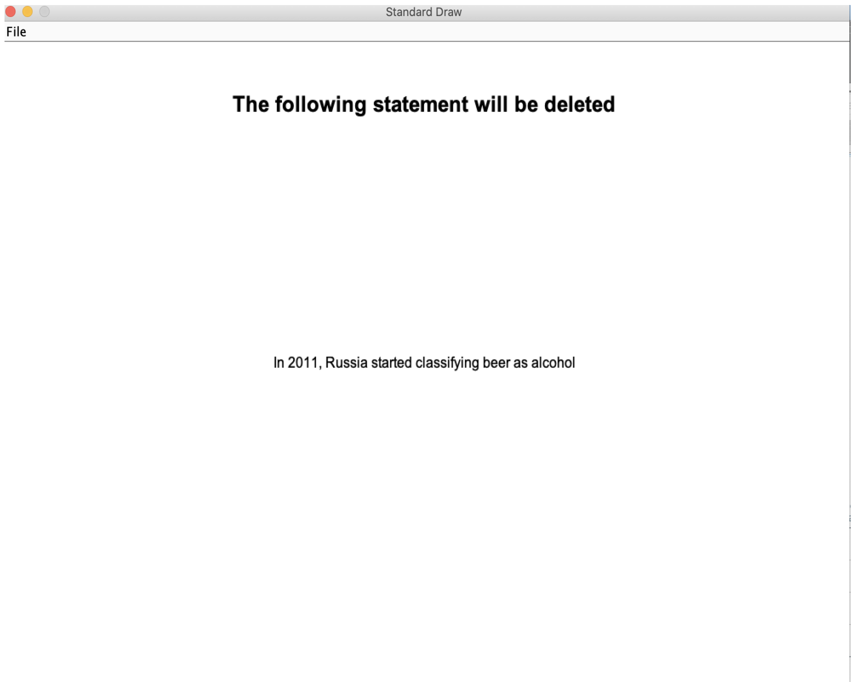


Figure 5: an example of what the system said when a fact was deleted

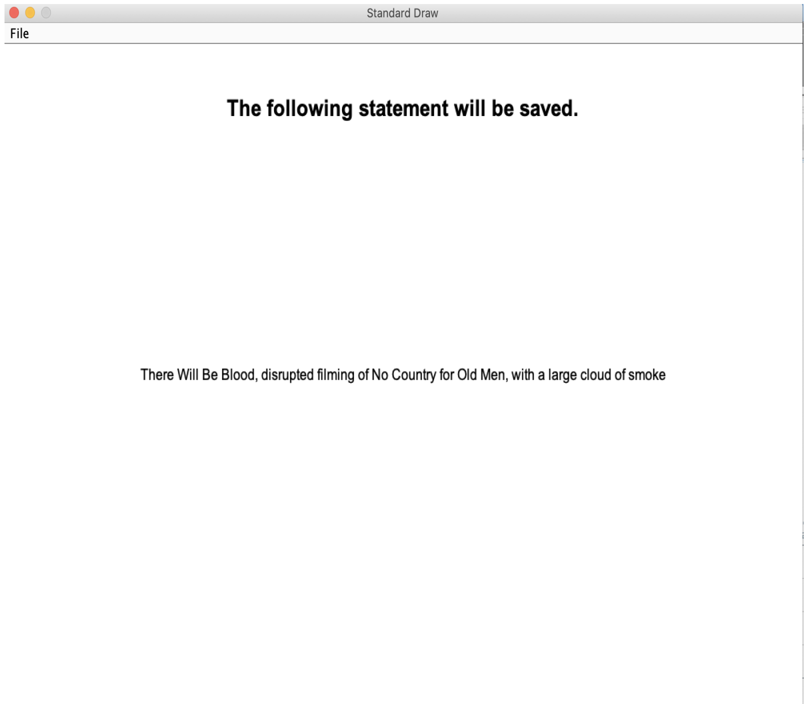


Figure 6 An example of what the system said when a fact was saved.

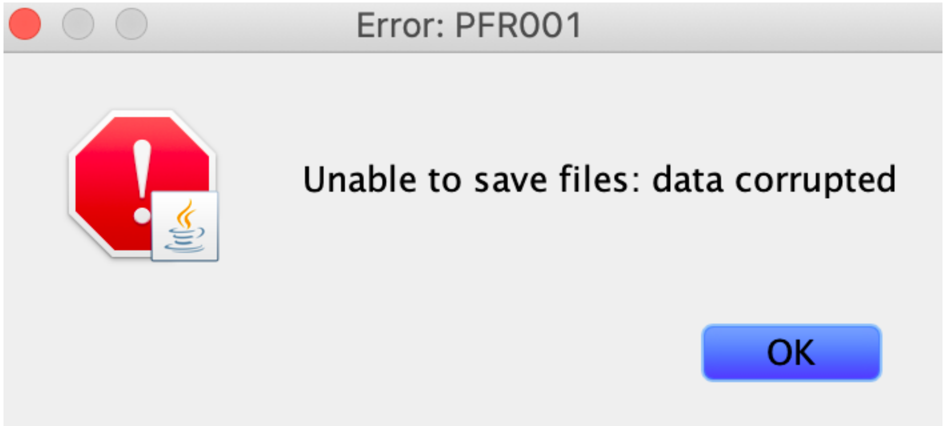


Figure 7: The error message that displayed if the participant was in the unreliable save condition.

Facts used

Main phase Experiment 1

1. Saddam Hussein has been executed.
2. Greenland is the world's largest island by area.
3. The Tsunami disaster in Asia occurred in December 2004.
4. A cow produces nearly 200,000 glasses of milk in her lifetime.
5. Bluebirds cannot see the color blue.
6. Michael Jackson was acquitted of molestation charges.
7. Only two countries border three oceans, the United States & Canada.
8. There was a terrorist bombing in the subways of London in July 2005.
9. There have been 43 presidents of the United States.
10. Ingrown toenails are hereditary.
11. ABC news anchor Peter Jennings was a high school dropout from Canada.
12. Pope Benedict XVI deserted the German Army during World War II.
13. The highest point in Pennsylvania is lower than the lowest point in Colorado.
14. Europe is the only continent without a desert.

15. The collapse of the Larsen B ice shelf in Antarctica began in January 2002.

16. The space shuttle Columbia disintegrated during re-entry over Texas in Feb 2003. 17. The international telephone dialing code for Antarctica is 672.

18. A quarter has 119 grooves around the edge.

19. Rubber bands last longer when refrigerated.

20. French Fries are originally from Belgium, not France.

21. Al Capone's business card said he was a used furniture dealer.

22. Without glasses, John Lennon was legally blind all of his life

23. The Atlantic Ocean is saltier than the Pacific Ocean.

24. The Dominican Republic has the only national flag with a bible in it.

25. The Live 8 concerts took place in the G8 nations and South Africa in July 2005.

26. The NATO bombing of Yugoslavia began in March 1999.

27. There is an average of 178 sesame seeds on a McDonald's Big Mac bun.

28. In Chinese script, there are more than 40,000 characters.

29. An ostrich's eye is bigger than its brain.

30. A person burns more calories when sleeping than when watching television.

Practice Phase Experiment 1

1.Peanuts are one of the ingredients of dynamite.

2.Babe Ruth earned the nickname The Sultan of Swat for his home run hitting ability.

3.The K-pg boundary separates the Cretaceous from the Paleogene period.

4.A person will shed over 40 pounds of skin in their lifetime.

5.The most expensive painting in the world sold for $450 million.

6.The great Pyramids of Giza are the only one of the Seven Wonders of the Ancient World that still exists.

7.North Korea announced that it had conducted a successful nuclear test in Oct 2006.

8.The first postmaster general of the USA was Benjamin Franklin.

9.A shrimp's heart is in its head.

10.Albert Einstein's first job after graduation was evaluating patent applications for electromagnetic devices.

11.The Himalayan mountains continue to grow due to the collision of tectonic plates.

12.Harry Potter and the Philosophers stone was published in June 1997.

13.Chechen separatists in Southern Russia took a school hostage in Sept 2004.

14.On August 31st 2009, Disney announced it had acquired Marvel Studios.

15.The longest classical composition would take 639 years to perform.

Practice Phase Experiment 2

1.The most expensive painting in the world sold for $450 million.

2.The first host of Jeopardy was Art Flemming

3.Finland has the most metal bands per capita

4.The first photograph ever taken in 1826 took 8 hours to expose

5.The first postmaster general of the USA was Benjamin Franklin.

6.Scientists can make diamonds out of peanut butter",

7.O.J. Simpson was almost cast as the Terminator, but James Cameron thought he was “too pleasant” to portray a dark character.

8.Africa is the only continent that covers four hemispheres”,

9.On August 31st 2009, Disney announced it had acquired Marvel Studios. ",

10.A cloud can weigh over a million pounds","

11.Banksy stuck his own work to the wall in the Tate Modern Museum in 2003

12.The Philadelphia Eagles and the Pittsburgh Steelers once combined to form the Steagles

13.The K-pg boundary separates the Cretaceous from the Paleogene period.

14.Harry Potter and the Philosophers Stone was published in June 1997.

15.A snail can sleep for three years

Main Phase Experiment 2

Animals

It takes a sloth two weeks to digest its food
A group of ferrets is called a business
A grizzly bear's bite is strong enough to crush a bowling ball

Movies

There were 10,297 Balloons in the film Up
Psycho is the first U.S. film that featured a toilet flushing
There Will Be Blood, disrupted filming of No Country for Old Men, with a large cloud of smoke

TV

The longest running animated sitcom is the Simpsons
Game of Thrones was filmed in the same factory that made the RMS Titanic
Footage from an episode of "Curb Your Enthusiasm" cleared a man of murder in real life

Geography

California has more people than all of Canada
Reno, Nevada is west of Los Angeles
The entirety of the world's population could easily fit in Texas

Art

Painting the Mona Lisa's lips took Leonardo da Vinci 12 years
Nighthawks by Hopper was painted in 1942
Salvador Dali believed he was his dead brother's reincarnation

Food

Fritos are made from just three ingredients
Pringles won a lawsuit proving they weren't potato chips
In 2011,Russia started classifying beer as alcohol

Science

In an entire lifetime, the average person walks the equivalent of five times around the world
Water can boil and freeze at the same time
There are extraterrestrial dust particles on your rooftop, from micrometeorites

Technology

The Macintosh was released in January 24th, 1984
HP, Google, Microsoft, and Apple all started in garages
Around 90% of the messages sent through various messaging services are read within 3 minutes

The Macintosh was released in January 24th, 1984
HP, Google, Microsoft, and Apple all started in garages
Around 90% of the messages sent through various messaging services are read within 3 minutes

Sports

Olympic gold medals are actually made of silver
The Stanley Cup was originally two stories tall but was deemed too difficult to transport
There have been 3 Olympic Games held in countries that no longer exist
The British Navy uses Britney Spears songs to scare of pirates
Mozart sold more CDs than Beyoncé in 2016
The first, and only, band to play on all seven continents is Metallica

Music

The British Navy uses Britney Spears songs to scare of pirates
Mozart sold more CDs than Beyoncé in 2016
The first, and only, band to play on all seven continents is Metallica

References

Ashleigh, & Prichard, J. (2011). An integrative model of the role of trust IN transactive Memory Development. *Group & Organization Management*, *37*(1), 5–35. https://doi.org/10.1177/1059601111428449

Baddeley, A. D., Eysenck, M. W., & Anderson, M. C. (2009). *Memory*. Psychology Press.

Barr, N., Pennycook, G., Stolz, J. A., & Fugelsang, J. A. (2015). The brain in your pocket: Evidence that Smartphones are used to supplant thinking. *Computers in Human Behavior*, *48*, 473–480. https://doi.org/10.1016/j.chb.2015.02.029

Barreau, D. K. (1995). Context as a factor in personal information management systems. *Journal of the American Society for Information Science*, *46*(5), 327–339. https://doi.org/10.1002/(sici)1097-4571(199506)46:53.0.co;2-c

Belluz, J., Resnick, B., & Barclay, E. (2018, November 28). *Is our constant use of digital technologies affecting our brain health? We asked 11 experts.* Vox. https://www.vox.com/science-and-health/2018/11/28/18102745/cellphone-distraction-brain-health-screens-kids.

Benn, Y., Bergman, O., Glazer, L., Arent, P., Wilkinson, I. D., Varley, R., & Whittaker, S. (2015). Navigating through digital folders uses the same brain structures as real world navigation. *Scientific Reports*, *5*(1). https://doi.org/10.1038/srep14719

Bergman, O., & Whittaker, S. (2016). *The science of managing our digital stuff*. The MIT Press.

Bjork, R. A., & Bjork, E. L. (1992). A new theory of disuse and an old theory of stimulus fluctuation. *Learning Procsesss to Cognitive "Processes: Essays in Honor of William K. Estes*, *2*, 35–67.

Chu, K. (2015). *Agent-Technology Interactions: Is the Computer a Transactive Memory Partner?* (dissertation).

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, *82*(6), 407–428. https://doi.org/10.1037//0033-295x.82.6.407

Conover, A. (2016, December 4). *Adam Ruins the Internet*. truTV.com. https://www.trutv.com/shows/adam-ruins-everything/articles/adam-ruins-the-internet.

Dudai, Y., & Edelson, M. G. (2016). Personal memory: Is it personal, is it memory? *Memory Studies*, *9*(3), 275–283. https://doi.org/10.1177/1750698016645234

Dunn, T. L., & Risko, E. F. (2015). Toward a Metacognitive Account of Cognitive Offloading. *Cognitive Science*, *40*(5), 1080–1127. https://doi.org/10.1111/cogs.12273

Ebbingham, H. (1885). *Memory: a contribution to experimental psychology*. Teachers College, Columbia University.

Ferguson, A. M., Mclean, D., & Risko, E. F. (2015). Answers at your fingertips: Access to the Internet influences willingness to answer questions. *Consciousness and Cognition*, *37*, 91–102. https://doi.org/10.1016/j.concog.2015.08.008

Global Council on Brain Health. (2019). The Real Deal on Brain Health Supplements: GCBH Recommendations on Vitamins, Minerals, and Other Dietary Supplements. https://doi.org/10.26419/pia.00094.001

Gupta, N., & Hollingshead, A. B. (2010). Differentiated versus integrated transactive memory effectiveness: It depends on the task. *Group Dynamics: Theory, Research, and Practice*, *14*(4), 384–398. https://doi.org/10.1037/a0019992

Hardt, O., Einarsson, E. Ö., & Nader, K. (2010). A bridge Over Troubled Water: RECONSOLIDATION as a link between cognitive and Neuroscientific memory RESEARCH TRADITIONS. *Annual Review of Psychology*, *61*(1), 141–167. https://doi.org/10.1146/annurev.psych.093008.100455

Hart, J. T. (1965). Memory and the feeling-of-knowing experience. *Journal of Educational Psychology*, *56*(4), 208–216. https://doi.org/10.1037/h0022263

Hollingshead, A. B. (1998). Retrieval processes in transactive memory systems. *Journal of Personality and Social Psychology*, *74*(3), 659–671. https://doi.org/10.1037//0022-3514.74.3.659

Hollingshead, A. B. (2000). Perceptions of Expertise and Transactive Memory in Work Relationships. *Group Processes & Intergroup Relations*, *3*(3), 257–267. https://doi.org/10.1177/1368430200033002

Hollingshead, A. B., & Brandon, D. P. (2003). Potential Benefits of Communication in Transactive Memory Systems. *Human Communication Research*, *29*(4), 607–615. https://doi.org/10.1111/j.1468-2958.2003.tb00859.x

Hollingshead, A. B., & Fraidin, S. N. (2003). Gender stereotypes and assumptions about expertise in transactive memory. *Journal of Experimental Social Psychology*, *39*(4), 355–363. https://doi.org/10.1016/s0022-1031(02)00549-8

Hu, X., Luo, L., & Fleming, S. M. (2019). A role for metamemory in cognitive offloading. *Cognition*, *193*, 104012. https://doi.org/10.1016/j.cognition.2019.104012

Klein, S. B., & Loftus, J. (1988). The nature of self-referent encoding: The contributions of elaborative and organizational processes. *Journal of Personality and Social Psychology*, *55*(1), 5–11. https://doi.org/10.1037/0022-3514.55.1.5

Konrad, A., Isaacs, E., & Whittaker, S. (2016). Technology-Mediated Memory. *ACM Transactions on Computer-Human Interaction*, *23*(4), 1–29. https://doi.org/10.1145/2934667

Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior*, *13*(5), 585–589. https://doi.org/10.1016/s0022-5371(74)80011-3

Marsh, E. J., & Rajaram, S. (2018). Cognition in the internet age: What are the right research questions to ask? In Invited talk at the Annual Meeting of the Association for Psychological Science.

Mueller, P. A., & Oppenheimer, D. M. (2014). The Pen Is Mightier Than the Keyboard. *Psychological Science*, *25*(6), 1159–1168. https://doi.org/10.1177/0956797614524581

Neath, I., & Surprenant, A. M. (2007). *Human memory: an introduction to research, data, and theory*. Thomson/Wadsworth.

Nelson, T. O. (1990). Metamemory: A Theoretical Framework and New Findings. *Psychology of Learning and Motivation*, 125–173. https://doi.org/10.1016/s0079-7421(08)60053-5

Risko, E. F., & Dunn, T. L. (2015). Storing information in-the-world: Metacognition and cognitive offloading in a short-term memory task. *Consciousness and Cognition*, *36*, 61–74. https://doi.org/10.1016/j.concog.2015.05.014

Risko, E. F., & Gilbert, S. J. (2016). Cognitive Offloading. *Trends in Cognitive Sciences*, *20*(9), 676–688. https://doi.org/10.1016/j.tics.2016.07.002

Rousseau, J.-J. (1797). *A dissertation on political economy: to which is added, a treatise on the social compact ; or the principles of politic law.* (G. Fairman, Ed.). Printed and sold by Barber & Southwick, at Faust's Statue, below the Dutch Church, State-Street.

Schacter, D. L. (2009). *The seven sins of memory how the mind forgets and remembers*. W. Ross MacDonald School Resource Services Library.

Schacter, D. L., Wegner, D. M., & Gilbert, D. T. (2009). *Psychology*. Worth Publ.

Sparrow, B., Liu, J., & Wegner, D. M. (2011). Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips. *Science*, *333*(6043), 776–778. https://doi.org/10.1126/science.1207745

Storm, B. C., & Stone, S. M. (2014). Saving-Enhanced Memory. *Psychological Science*, *26*(2), 182–188. https://doi.org/10.1177/0956797614559285

Storm, B. C., Stone, S. M., & Benjamin, A. S. (2016). Using the Internet to access information inflates future use of the Internet toÂ access other information. *Memory*, *25*(6), 717–723. https://doi.org/10.1080/09658211.2016.1210171

Tulving, E., & Schacter, D. L. (1995). *Memory systems 1994*. MIT Press.

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*(5), 352–373. https://doi.org/10.1037/h0020071

Tversky, A., & Kahneman, D. (1991). Loss Aversion in Riskless Choice: A Reference-Dependent Model. *The Quarterly Journal of Economics*, *106*(4), 1039–1061. https://doi.org/10.2307/2937956

Wegner, D. M. (1987). Transactive Memory: A Contemporary Analysis of the Group Mind. *Theories of Group Behavior*, 185–208. https://doi.org/10.1007/978-1-4612-4634-3_9

Wegner, D. M. (1995). A Computer Network Model of Human Transactive Memory. *Social Cognition*, *13*(3), 319–339. https://doi.org/10.1521/soco.1995.13.3.319

Wegner, D. M., Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality and Social Psychology*, *61*(6), 923–929. https://doi.org/10.1037//0022-3514.61.6.923

Weis, P. P., & Wiese, E. (2018). Using tools to help us think: Actual but also believed reliability modulates cognitive offloading. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *61*(2), 243–254. https://doi.org/10.1177/0018720818797553

Whittaker, S., Bergman, O., & Clough, P. (2009). Easy on that trigger dad: a study of long-term family photo retrieval. *Personal and Ubiquitous Computing*, *14*(1), 31–43. https://doi.org/10.1007/s00779-009-0218-7

Wickham, L. H. V., & Swift, H. (2006). Articulatory suppression attenuates the verbal overshadowing effect: a role for verbal encoding in face identification. *Applied Cognitive Psychology*, *20*(2), 157–169. https://doi.org/10.1002/acp.1176

Yacci, M., & Rozanski, E. P. (2012). Student information consumption strategies. *Proceedings of the 2012 IConference on - IConference '12*. https://doi.org/10.1145/2132176.2132208

Yuan, Y. C., Monge, P. R., & Fulk, J. (2005). Social Capital And Transactive Memory Systems In Work Groups: A Multilevel Approach. *Academy of Management Proceedings*, *2005*(1). https://doi.org/10.5465/ambpp.2005.18779786