AUTOMATICITY OF DIGITAL ACCESSIBILITY IN MEMORIZATION

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Supervisor: Tim Curran Student: Kyler Miller

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Committee Members:

Neeraja Sadagopan: Speech, Language and Hearing Sciences

Mark Whisman: Department of Psychology and Neuroscience

Abstract

As computers and smartphones see more widespread use in society today, multiple studies have arisen to explore their effects on learning and memory, and if they are truly as beneficial a tool as they are understood to be. Prior research suggests that digital accessibility results in poorer encoding of information due to individuals automatically perceiving an increased availability because of computers' more mainstream use. This study attempts to explore this effect through two experiments modeled after an experiment by Schwikert (2017) that presents stimuli to participants, telling them through pre-cues "Saved" and "Erased" that half of the stimuli will be available for review before the test phase (Saved), and the other half will not (Erased). Schwikert found that information marked with the "Erased" pre-cue was later remembered better than those marked with the "Saved" pre-cue. The present Experiment 1 uses the design from Schwikert's experiment, except it does not explicitly mention a future accessibility to participants, and rather implies it by informing them that the stimuli presented will be stored online. It was designed to determine if there is an automaticity of digital accessibility, by removing the explicit instructions. The second experiment was identical to Experiment 1, except that participants were explicitly told they would have access to the "Saved" stimuli, more similar to Schwikert's experiment. Experiment 1's results found saved pairs being recalled better than erased pairs, while Experiment 2's found erased pairs being recalled better than saved pairs (replicating Schwikert, 2017), suggesting that only implying that information is stored online is not enough to elicit an automatic response to cognitively offload information.

Introduction

The rate at which new revolutionary technologies are being invented is growing exponentially. Every time a new technological advancement is published, the time it will take for the next advancement to appear is halved, or less. Because of this, humans have grown increasingly adaptive to changes occurring around them and they expect new and better advancements every day. One of the best examples of this is the creation of the personal/home computer. This tool has become one of the largest-used resources for a multitude of applications including research, entertainment, studying, and note taking. Recent research seems to show that the brain has adapted to use the computer in a way that was initially unexpected (Dror, 2008; Kirsh, 1994; Tversky, 2010; Ward, 2013; Sparrow, 2011).

The integration of the computer into mainstream society has caused an increase in rapid information transfer. Computers have increasingly been used to cognitively offload information, as humanity shifts from the use of printed storage to digital storage. This type of offloading is a kind of memory aid, defined as "devices or strategies that are deliberately used to enhance memory" (Intons-Peterson, 1986, p. 267). There are two kinds of memory aids: internal and external. Internal aids are tricks used to try and remember important information, such as mental rehearsing and alphabetical searching, typically limited to one's own mental capabilities. External aids, on the other hand, are any sort of outside help recruited to aid in memorization, such as lists, notes, or even friends. (Intons-Peterson, 1986). Computers fall into this second category.

Despite the distinct difference in tangibility between the two kinds of memory aids, there is another key difference that is important to identify: the amount of effort required. With internal memory aids, the brain works hard at keeping the information stored within and spends a

lot of energy and time rehearsing it. On the other hand, external memory aids allow the brain to offload the information onto another source, freeing up space and energy for other tasks (Intons-Peterson, 1986; Intons-Peterson, 1992). Returning once more to the computer, it's higher storage capacities and increased accessibility enables it to be a more efficient source of storage. Because of this, natural memory, and thus internal memory aids, is becoming less and less utilized. Furthermore, as our brains offload extra information onto the computer and the internet, some research seems to suggest that instead of being able to memorize the specific information being saved online, we are instead able to remember the keywords used, or the website accessed that had the information saved on it (Sparrow, 2011; Ward, 2013). This same effect has been seen before with the use of paper sources, but to a much lesser degree. For example, some students will experience a moment when taking a test for a class where they might not be able to recall the answer needed for a particular test question. However, they are able to give the textbook, chapter, and even specific location on a page where the answer can be found (Intons-Peterson, 1986; Intons-Peterson, 1992).

Following this concept, there is also newer research showing that this location saving is causing an increase in confusion as the brain mixes up how much of the information it has received is stored internally or externally (Hinsz, 1990; Wegner 1995), suggesting that people have begun to confuse information found online with information they previously knew. In a study completed by Ward (2013) subjects were given 60 trivial facts to answer; 30 using a search engine to answer, and 30 using prior knowledge. In a later test phase, the participants were presented with the same 60 facts plus 20 new ones and were told to respond either by saying they did not know the answer, they do know the answer and got the answer from the search engine or do know the answer from their own previous knowledge. The results found that most participants

overestimated how many of the questions they knew the answer to were ones they had known previously. This research seems to suggest our minds have begun integrating computers into our cognition, leading to an automaticity of digital accessibility.

Instructing to Forget

There are many simple experiments that utilize the concept of cues given to subjects before or after being told to study some sort of object; relying on object, word, or sentence memorization. Recent research has begun looking into the effect of being instructed to forget items before or after memorization to study the effect (Richard, 1971; Sahakyan, 2003).

The type of experiment designed to have subjects forget words after learning them is called *directed forgetting* (MacLeod, 2012). There are two methods of assignment for post-object cued directed forgetting: the item method, and the list method. The item method focuses on prioritizing specific stimuli by presenting the instruction to remember or to forget after each item is shown. In this case, it is possible to randomize the decision of forgetting verses remembering and focus more on individual item effects. The list method, on the other hand, focuses on presenting half of the words in a list, then instructing the participant to forget or remember the first half of the list. In this case, the results would be focused more on the ability to retroactively forget large amounts of information rather than individual items.

The results of these studies tend to show that memory of items told to be forgotten is generally lower than that of the objects instructed to remember, whether or not the item method or the list method is used (MacLeod, 2012; Harnishfeger, 1996; Sahakyan, 2003). These findings

seem to suggest that humans have the ability to erase items being kept in the short-term memory and keep them from being transferred into long-term memory.

When participants are instructed to forget words before memorization, the same occurs: they tend to forget the items studied. The hypothesis as to why this effect is present, however, attributes this forgetfulness to a lack of attention when told to forget rather than to some sort of memory destruction effect. The subjects realize that when told to forget an item, that simply not paying attention to it would decrease likelihood of memorization, and so they do not ever cognitively process the object. There is very little research using this design because of this problem (Schwikert, 2017).

Digital Directed Forgetting

Recent studies have begun attempting to discover the possible relationship in forgetting between the digital world and the physical. Some research was interested in whether or not the brain would automatically attribute the words “Saved” on a computer and “Erased” on a computer into “Forget this” and “Remember this” respectively. By recognizing that data saved on a computer is offloaded and forgotten, the idea attempts to combine cognitive offloading and directed forgetting.

In an experiment by Sparrow *et al* (2011), participants were given a set of 40 trivia questions to answer and were then told to type them and the answers into a computer. Half of the participants were told the data would be saved, and half were told the data would be erased. The idea was to produce an indirect directed forgetting due to a provided external storage. The results found that participants informed that the questions and answers were going to be saved had

worse memory of the trivia overall as compared to those told their input would be erased. This would suggest that there is, in fact, a relationship between cognitive offloading and directed forgetting.

In a recent, similar study completed by Schwikert (2017), the effects of implying future access to information on memory was tested again through the memorization of lookup-able and non-lookup-able facts (trivia facts that could be found online verses facts about a random unknown classroom of students respectively). Participants were provided with a trivia fact to remember one-by-one, with a pre-cue displayed before each fact. The "Saved" pre-cue implied that it would be available later for review before being tested on it, and the "Erased" pre-cue implied that it would not be available for review. As discussed earlier, directed forgetting was highly successful in pre-study cues, but this was likely because participants adjusted their attention elsewhere during the task. Schwikert's study was unlikely to experience a similar effect since participants were not told to forget items, but were instead implied to that some items have more of a priority in memorization than others.

Schwikert's (2017) study did find "Erased" trivia facts being recalled better than "Saved", implying that participants spent less time memorizing "Saved" trivia facts due to their ability to review later. One limitation of Schwikert's (2017) study, however, is that it is difficult to generalize the question it hopes to answer. Because it uses facts and includes a secondary variable of lookup-able and non-lookup-able, it is questionable about the generalizability to memory for other sorts of information.

Furthermore, the research reviewed, and Schwikert himself, suggests that the transition to digital technologies has produced an automatic response to externally offload information to digital sources (Sparrow, 2011; Ward, 2013; Intons-Peterson, 1986; Intons-Peterson, 1992). This

indicates that words implying digital accessibility could also automatically lead to a decrease in effort to encode information due to the engrained automaticity of computer use as external memory aids. The problem with Schwikert's (2017) conclusions in this regard, is that he explicitly tells participants they would have access to "Saved" trivia facts, which is different than participants assuming this themselves due to an ingrained understanding.

The present research attempts to further test this effect by following a design similar to Schwikert's (2017) study, while also filling in the holes. First, instead of using trivia facts, we are using word-pairs to try and generalize the effect to less specific stimuli. We also are not including a "lookup-ability" variable to simplify the experiment. Furthermore, all non-native English-speakers' results will be analyzed separately from native English-speakers to remove any possible unwanted variability. Finally, while we too are using "Saved" and "Erased" pre-cues, where "Saved" pairs are meant to be interpreted as pairs that the participants will have future access to, and "Erased" pairs are meant to be understood as having only a single chance to see them, it is never explicitly instructed that participants will have access to "Saved" pairs. Instead, participants are simply told "Saved" pairs will be saved online. If the theory of automaticity of digital accessibility is correct, then it should not require an explicit explanation that "Saved" pairs will be accessible later. We hypothesize that "Saved" word-pairs will be recalled less accurately than "Erased" pairs.

Experiment 1

Method

Participants

35 participants were recruited from the 2017-2018 University of Colorado, Boulder undergraduates taking the PSYC 1001 General Psychology class. The sample size was chosen to be as close as possible to the original experiment we tried to replicate, while also working within the availability of the limited subject pool. Sample participants were rewarded with 1 credit per half an hour of participation toward completion of a semester-long homework assignment to participate in experiments.

Materials

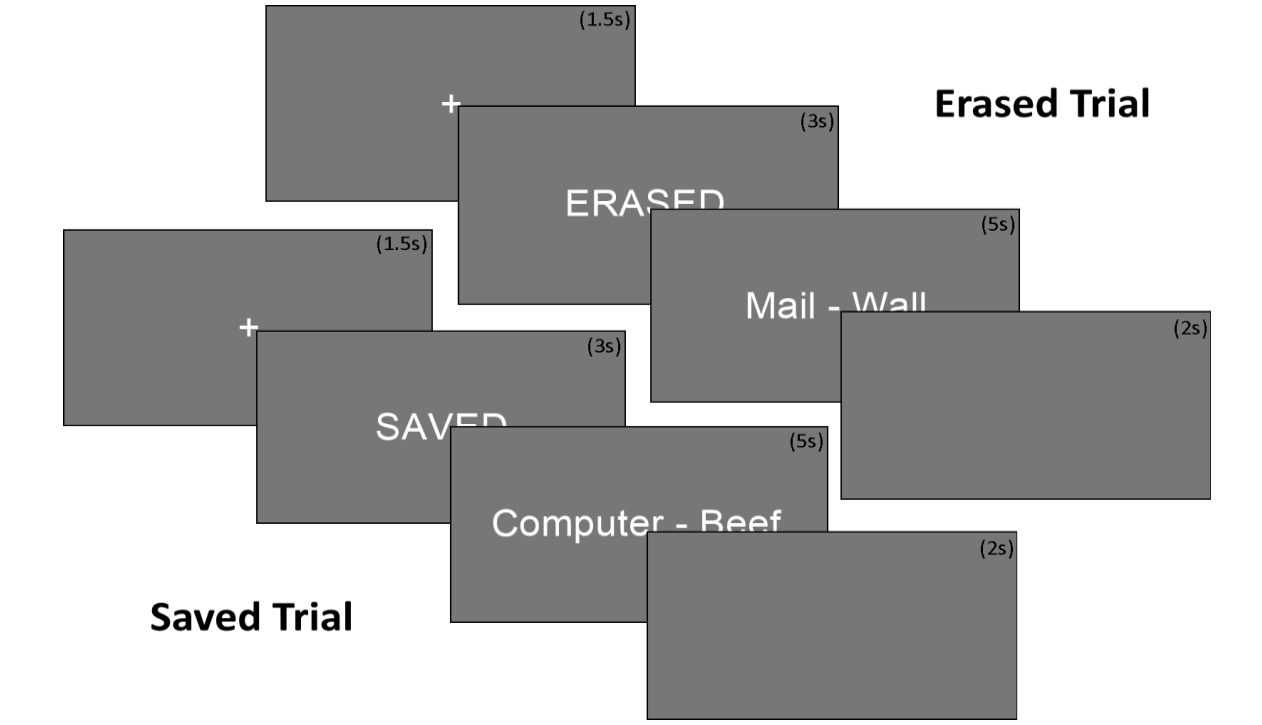
The experiment was administered through PsychoPi computer software. The experiment consisted of a study phase and a test phase, followed by a short questionnaire to collect the participant's first language, and their perceptions on the experiment. Stimuli consisted of a series of 46 previously unassociated word pairs given during the experiment.

Procedure

Participants completed the experiment within a controlled computer lab, which typically took less than half an hour to complete. It was a two-way (saved vs. erased) within-subjects study design. Subjects studied 46 word pairs (half "Saved", half "Erased") followed by a cued-recall test.

Each study trial began with a fixation cross on the screen for 1.5s, followed by a randomized pre-cue instruction (either "SAVED" [S] or "ERASED" [E]) for 3s, then a word-pair displayed for 5s. Following each set, there was a brief 2s blank screen to mark the separation of pairs. Figure 1 demonstrates 2 blocks of the study sequence for reference, one "Saved" block and one "Erased" block.

Figure 1
Presentation of Stimuli



Progression of each study trial began with a fixation cross for 1.5s, followed by the pre-cue for 3s, the word-pair for 5s, then a blank screen to mark a new pair for 2s.

The number of pre-cues were equal, with 23 repetitions each. Participants were told that all word pairs in the "Saved" category would be saved online but were not specifically told they would have access to the words, while all word pairs in the "Erased" category would not be saved online. The first and last 3 pairs that were displayed to participants were not included in the testing phase to remove any recency and primacy effects. After the study phase was completed, participants were given a minute as a break, as they read the instructions for the cued recall test phase. For this task, participants were presented with the first word from each of the presented word-pairs one at a time in a different random order and were asked to type the word they thought they remembered it was associated with. This phase was untimed, but generally took less than 10 minutes to complete.

Finally, once the test-phase was completed, participants completed a short 4-question questionnaire (Appendix A). The questionnaire asked participants what their native language was, how they interpreted the difference between "SAVED" and "ERASED" word pairs (interpretation), how the pre-cues affected their effort to memorize the word pairs (effort), and what they thought the hypothesis of the study was. This questionnaire was included to determine if the intended effect of the instructions was being made on participants.

Results

In this experiment, we measured the number of word pairs that each participant recalled in two conditions: Saved ($M = 3.80$, $sd = 4.42$) and Erased ($M = 3.00$, $sd = 3.99$). To examine if telling participants that they would have access to the information online affected their memory of one set of pairs over the other, we carried out a paired-sample t-test between Saved and Erased pairs. There was no significant difference between the two sets, $t(34) = 1.7755$, $p = 0.084$.

To control for the effect of language barriers, we originally planned to remove non-native English speakers from the analysis. When examining the same effect between Saved and Erased pairs between only native English speakers (Saved $M = 4.12$, $sd = 4.48$; Erased $M = 3.19$, $sd = 4.12$), there was still no significant difference, $t(31) = 1.9475$, $p = 0.06$. Notably, although this difference might be considered marginally significant ($p < .10$), the direction of the difference was opposite of what was predicted from Schwikert (2017). Schwikert (2017) found better memory for Erased than Saved items, but the present accuracy was numerically greater for Saved than Erased items.

We used the answers in the questionnaire to determine if participants held correct interpretations of the difference between Saved and Erased, and if they demonstrated increased effort to memorize "Erased" pairs. Interpretations that described the saved words as being saved online were classified as "correct" while ones that said anything else were classified as "incorrect". Answers detailing an increased effort on memorizing erased words were classified as "correct" while anything else was classified as "incorrect". The questionnaire resulted in 3% correct answers for the questions asking about participants' interpretations and 0% correct answers for the questions asking about participants' efforts.

Discussion

In Experiment 1, there was not a statistically significant effect between Saved and Erased word pairs. Looking at the means of the pairs suggested that Saved words were being memorized better than Erased pairs, which was the opposite of what was predicted. When scoring the questionnaires, it was revealed that only a single participant correctly interpreted the difference between pre-cues, and all answers to the question measuring the participants effort proved to be incorrect as well, meaning they were not studying the words as desired or expected.

Returning to Schwikert's (2017) experiment, the wording of the pre-cue "SAVED" was more specific than the wording in Experiment 1. In his experiment, it was specifically mentioned that participants would be able to restudy "Saved" stimuli before moving on to the test phase, which was not included in our Experiment 1. This was intentionally left out to explore the automaticity of digital accessibility effects. If this automaticity assumption was correct, then participates would not need to be explicitly instructed that they would have access to the pairs

later and it would rather just be a subconscious understanding by participants. However, because of the incorrect number of answers on the questionnaires, and the lack of significant difference between the pairs, this seems to suggest that the original hypothesis stating the word "Saved" would be enough to cause the participants to spend less effort encoding the word-pairs was incorrect. Thus, we changed the wording of Experiment 1 to be more consistent with the wording in Schwikert's (2017) experiment to see if we could replicate his results for word-pairs, resulting in Experiment 2. Assuming we did find an effect in Experiment 2, it would suggest that the effort put into encoding words is not affected by the automaticity of digital accessibility alone, but rather requires a direct statement suggesting later availability.

Experiment 2

Method

Participants

62 more participants were recruited from the 2017-2018 University of Colorado, Boulder undergraduates taking the PSYC 1001 General Psychology class. Everything else is constant with Experiment 1.

Materials

The same materials were used as Experiment 1 except that an additional 6 word-pairs were added for practice to stay more consistent with Schwikert's (2017) design.

Procedure

The experiment given remained the same as that in Experiment 1, but with a few minor changes. First, the introduction was changed to explicitly tell participants that they would have access to review all "Saved" word pairs before the test phase. Secondly, to stay consistent with Schwikert's (2017)'s study and increase the persuasion of the instructions, a 6-block practice phase was included before the study phase. The practice phase consisted of a practice-study phase, a practice-review phase, and a practice-test phase. During the practice-study phase, six-word pairs (three "Saved" and three "Erased") were studied identically to how the actual study phase would look. In the practice-review phase, participants were given a short period of time where all three "Saved" pairs were presented to the participant to restudy. This section is not included in the actual experiment and was included in the practice phase just to further enforce the idea that saved pairs would be accessible before the practice phase. In the practice-test phase, participants were tested on all six pairs, including those reviewed and those not. Everything else following this practice phase was consistent with the Experiment 1.

Results

Similar to Experiment 1, we measured the number of word pairs that each participant recalled in two conditions: Saved ($M = 6.85$, $sd = 5.59$) and Erased ($M = 8.24$, $sd = 5.89$). This time, the paired-sample t-test between Saved and Erased pairs had a significant difference between the two sets, $t(61) = -3.1471$, $p<0.01$, with Erased pairs being recalled better than Saved pairs.

Also exploring the difference between non-native and native English speakers, we examined the same effect between Saved and Erased pairs between only native English speakers

(Saved M = 7.67, sd = 5.83; Erased M = 9.4, sd = 5.91), where there was still a significant effect t(44) = -3.10, p = 0.01; but when examining the effect between only non-native English speakers (Saved M = 4.71, sd = 4.34; Erased M = 5.18, sd = 4.72), there was not a significant effect, t(16) = -0.8, p = 0.44.

Expanding further, we once against used the answers to the questionnaire to determine if participants held correct interpretations of the difference between “Saved” and “Erased”, and if they demonstrated an increased effort in memorizing “Erased” pairs. The only difference in scoring between Experiment 1 and this experiment is that for the interpretations question, interpretations that described the “Saved” words as being available for later study were classified as “correct”, while ones that said anything else were classified as “incorrect”. We decided to see if there was a difference between the number of correct interpretations (42%) on the memorization between pair type, and the number of correct responses to the question testing effort (50%) on the memorization between pair type. In order to test if the interpretations and efforts of participants were predictive of their answers, we ran a linear regression model predicting subjects’ accuracy difference between Saved and Erased pairs from the correctness of their (a) interpretation and (b) effort. There was not a significant effect of interpretation on accuracy differences, F(1, 60) = 0.261, p = 0.612, and there was not a significant effect of the interpretation/efforts interaction, F(1, 59) = 0.109, p = 0.743, but there was a significant effect of effort on pair differences, F(1, 60) = 7.425, p = 0.008. The means and standard deviations for each questionnaire variable is given on Table 1. Table 1 values are Saved-minus-Erased differences, so negative values in the table represent greater accuracy for Erased than for Saved pairs. The significant effect of effort shows that the subjects who answered the effort answer

correctly had a larger accuracy increase for erased over saved pairs (2.71) than subjects who answered the effort question incorrectly (.06).

Table 1

Means and Standard Deviations of Interpretation and Effort Correct Responses

Questionnaire Question	Interpretation		Effort	
	Mean	SD	Mean	SD
Correct Answers	-2.12	3.43	-2.71	3.43
Incorrect Answers	-0.86	3.45	-0.06	3.02
	p = 0.743		p<0.01	

Discussion

In Experiment 2, there was a statistically significant difference between Saved and Erased word pairs with Erased pairs being recalled better than Saved pairs in both the native English-speaking group and the combined group of participants, but not in the Non-Native English-speaking group. This difference could be due to the low number of participants in the Non-Native group, since it did not seem to affect the significance of the entire group of participants, though the mean differences in the Non-Native group seem much lower than the Native group. We also found that effort significantly predicted the difference in correct responses between pair types, suggesting that having an explicit intent to focus on Erased pairs is required for participants to demonstrate an increased recall of Erased pairs over Saved pairs.

General Discussion

In Experiment 1, participants were told that "Saved" word-pairs would be saved online, while Erased words would not. It was designed differently from Schwikert's (2017) experiment to see whether his assumption that years of computer use has led to an automaticity of digital accessibility is true. Had significant differences been found in Experiment 1, it would suggest that just mentioning items being saved on a computer is enough to alter individuals' effort to memorize them. The results of this experiment however, showed an opposite, though not significant, effect: that Saved word pairs were memorized better than Erased word pairs. Experiment 2 was created to ensure the desired effect, telling participants they would have access to Saved pairs, and gave participants a practice phase to further convince them of this ability. It was designed as close to Schwikert's study as possible in order to determine if the "Saved" pairs being recalled better than "Erased" pairs from Experiment 1 was due to different stimuli (word-pairs) or if the hypothesis was actually incorrect.

The results of Experiment 2 found a significant difference between the word-pairs in the hypothesized Erased > Saved direction, and thus demonstrates a need for individuals to explicitly recognize a lack of access to information to be more inclined to put less effort in encoding, which it appears digital vocabulary does not provide. This implies that the theory suggested in Schwikert's (2017) experiment, that our interaction with computers has led to an automatic propensity to put less effort into encoding information found on a computer, is not supported. Cognitive offloading resulting in less memory retention from using digital sources as external memory aids (Sparrow, 2011; Ward, 2013; Intons-Peterson, 1986; Intons-Peterson, 1992) was not induced simply by implying digital accessibility.

Experiment 2 did, however, reinforce the generalizability of Schwikert's (2017) results to more types of stimuli, due to the significant recall advantage for Erased over Saved word-pairs. The results of this experiment also demonstrate that this effect is observed in an educational population, adding more support to the growing literature showing that using a computer results in decreased memory of the information stored online (Ward, 2013; Sparrow, 2011; Schwikert, 2017). It just does not acknowledge the automaticity implied by past experiments.

Finally, in Sparrow's (2011) Experiment 2, Sparrow found that telling people that items would be Saved onto a computer without explicitly saying they would be available for review later led to a decrease in recall accuracy for those items later. In the study, participants were tasked with looking up answers to 40 trivia questions. Half of the participants were told the search engine would save their history, the other half were told it would be erased. Sparrow found that participants who were told that their inputs would be erased had a higher average number of correct recalls compared to the participants in the saved condition. These results were attributed to the perception that search engines are continuously available, and so individuals may not feel the need to encode information internally. The results of our study however, directly contradict the findings of Sparrow's experiment, since Experiment 1, which was supposed to determine if individuals would automatically put less energy into encoding information they perceived was saved online, found Saved words being memorized better than Erased words. This conflicted evidence, however, could be due to the nature of Sparrow's manipulation of Saved vs Erased pre-cues. When the participants typed the trivia questions into the search engine, they were able to see the direct result of their actions as the computer did in fact save their responses or not. Our Experiment 1 was quite extreme, only barely mentioning the fact that items were saved or not. Due to the conflicting evidence found in these studies and the

differences in instructions, it would be important for further replications to be completed to better understand this effect and to what degree it is applicable.

Limitations

The first limitation of this study was the wording of the instructions in Experiment 1. The unclear wording used to try and illicit the same understanding of Experiment 2 without explicitly mentioning the provision of review for Saved pairs led to 31% of participants believing they would not be tested on Erased word pairs.

All participants tested in Experiment 1 were from the end of the semester. Due to the nature of the subject pool (providing credit towards in-class assignments), participants recruited at the end of the semester are more likely to provide less accurate results because they are more concerned with getting the credits in time instead of engaging with the experiment as a learning experience. All participants in Experiment 2 were recruited at the beginning of the next semester, which could have led to the increased number of correct responses (the combined mean of correct answers for Experiment 1 is 6.8, sd = 7.99, and combined mean of correct answers for Experiment 2 is 15.1, sd = 10.95).

Another limitation for this study could be the low number of non-native English speaker participants (17 in Experiment 2). To explore if the tested hypothesis is demonstrated across language ability, we ran separate t-tests for native and non-native English speakers, resulting in non-native English speakers having no significant difference between pair types. We suspect that the lack of significance is due to the low number of participants, and if more non-native speaking participants were included in the study, we would see a significant result. Finally, despite a significant difference between word pairs, participants' interpretations of the experiment not

predicting the difference in word pairs would seem to suggest that participants do not need to know they will have access to the words later, which disagrees with the compared results of Experiment 1 and Experiment 2. This problem, however, could instead suggest an error in wording for the questionnaire or the instructions, since the number of correct interpretations was much lower than expected, and quite a large number of participants (32%) thought the second question in the questionnaire (meant to test their interpretations) asked what the relationship was between pairs, within pair-type. In other words, 32% of participants gave answers to this question similar to "Erased [were] words that were related, Saved [were] not related [to each other]."

Real World Implications and Future Directions

As discussed in the introduction of this paper, there is a large body of research and debate over the effects of online or digital note-taking on an individual's ability to memorize or learn information. The results of this study support the idea that when an individual assumes they will have access to important information at a future time, they put less effort into encoding, which results in poor long-term retention. The responses on the questionnaires seem to indicate this trend in the direction of decreased attention on Saved word pairs, rather than increased attention to Erased pairs, since most participants that answered correctly indicated they thought they would see Saved word pairs again, and thus paid less attention to them. One suggested follow up experiment would replicate the wording and stimuli in this experiment but would also include a control condition (similar to Schwikert's (2017) study) to see if the presence of digital vocabulary would alter results from a simple memorization task of word-pairs without pre-cues. If statistically significant differences were found between memorization in a control condition and memorization in Saved/Erased conditions, it could indicate an increased amount of effort or

decreased amount of effort depending on the direction of the relationship. Specifically, if Saved pairs were memorized less accurately than pairs in the control condition, it could further reinforce the idea that participants are explicitly reducing the amount of effort in encoding Saved pairs. On the other hand, if Erased pairs were memorized more accurately than control pairs, it could suggest that participants are focusing more effort on encoding Erased pairs rather than decreasing their effort in encoding Saved pairs.

In order to generalize this effect across language, a separate experiment could look at the difference between the effect of perceived accessibility on other languages. This study, while it did split the differences between native and non-native English speakers, did not specifically study the differences between languages, and so another study that is able to present this same study design to individuals from other countries would be beneficial as a next step. Due to the lack of significant difference in the non-Native English category, it is difficult to determine if this is a result of low subject number, lack of English comprehension, or if there is a possibility that digital keywords and perceived accessibility would be interpreted separately than how it is in the English language.

Another good follow-up experiment would be to explore this same effect in a more natural setting. The study these experiments were based off used trivia facts (Schwikert, 2017), and this study used word pairs, but to properly explore the effects of perceived accessibility in a classroom setting, it would require more of a field study procedure to accomplish, and a different, more specific set of stimuli in order to further generalize the results found in both this and Schwikert's study.

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Appendix A: Questionnaire

Post-Experiment Questionnaire

Please answer the following questions as truthfully as possible

1. What is your first language?

2. While completing the study, what did you interpret was the difference between the “SAVED” and “ERASED” word pairs?

3. How did the words “SAVED” and “ERASED” affect your effort to memorize the word pairs?

4. What do you think is the hypothesis of this research study?

Thank you for answering these questions. Please see the experimenter for your credit assignment and feedback form.