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The Effect of Physical Interaction on Evolving Attention Relating to Advertisements and Visual Information

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The Effect of Physical Interaction on Evolving Attention Relating to Advertisements and Visual Information

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Abstract

As more technology is used on a daily basis around the world, the platforms of advertisements and learning have also changed. However, little is known about the effects of image and video interaction type on information retention. The current research examines the effect of different types of interaction such as swiping, tapping or viewing on memory of an image both with and without using the same interaction when the participants were asked if they remembered the image or not. In experiment one, the participants from the Connecticut College subject pool used a hand tracker system to swipe and tap images after being instructed by an audio or visual cue. They were then asked which images they remembered in the second portion of the experiment that contained images intermixed with ones that they had never seen before. The second experiment was set up similarly, but contained swiping, tapping and viewing images. The images used to swipe had an element of movement and the same action was used in the recall portion of the experiment. For example, if the participant swiped during the learning portion, they were then asked to swipe to indicate if they recalled seeing the image. The results indicated that swiping was more effective at helping participants to remember the images compared to tapping or viewing, but this was only the case when the swiping images had some sort of movement associated with the object in the image and when the same type of interaction was used during the recall portion. The results help to demonstrate the importance of considering physical interaction with an image and how it affects subsequent memory, which is particularly important in the age of smartphones.

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The effect of physical interaction on evolving attention relating to advertisements and visual information

Ever wonder how many people actually pay attention to the advertisements on the side of a website? Or even care to watch the ads at the beginning of a YouTube video? As technology continues to grow with greater importance in our everyday lives, it is becoming even harder to portray information in a way that will catch attention. With constant moving images, banners, popping words and more, it feels as though the more something actively tries to get our attention, the more we ignore and forget about it (Hong, Thong & Tam, 2004; Lee, & Ahn, 2012; Moher, Anderson, & Song, 2015). So, how do people get important messages across in a way that makes you actually remember what you were looking at? With the growing importance of technology in our lives, finding ways to catch attention and cause people to remember what they see is becoming even more difficult.

Advertising may not be the only instance where technology is a distraction or where it might be causing challenges in the way someone remembers what they see. In classrooms, memorization and note taking is also becoming an issue for many teachers and professors attempting to engage their students. When using different types of technology such as cell phones and laptops, unless students are physically interacting with the information, often it is harder for them to remember the information that is presented (Mueller & Oppenheimer, 2014).

Attention and Memory

When thinking about the idea of attention, there are many different ways that attention to a certain object can play a role in how well an individual may remember that object. For

example, attention could vary depending on the context you are using to view the object or your need to remember it. Attention is often defined or referred to as a state of current awareness in response to the environment (McCallum, 2015). However, how you pay attention can also be grouped into a few different categories such as having limited attention, which is an individual's inability to process all the information around them (Cherry, 2019; Hirshleifer & Teoh, 2003). Another way someone can pay attention is by using selective attention where you are only focusing on one sensory input at a time and this is often where an individual is able to block out noise or information that is not necessarily important to an immediate function (Cherry, 2019; Yantis, 2008). With many changing images and screens on cell phones, tablets and televisions, paying attention to specific messages, unless there is something to grab the attention, is becoming more challenging. This is where selective and limited attention can be affected.

Attention and memory are necessary to group together because in relation to advertisements, teaching and more, remembering what you see is important. But, it is often difficult for other people to make you remember information that might be boring or unappealing to your current functioning, and if you do not pay attention to something in the first place, you will not remember it. Each time you are consciously paying attention to something or physically interacting with it on a cell phone or tablet, your brain puts the information into short-term memory then that will often be followed by consolidation in long-term memory (McGaugh, 2000). And if that information is not immediately relevant to your functioning, it will likely help you remember what you saw for a short period of time, but after that, it may be harder to resurface. As new ways of clicking, tapping, swiping and interacting with a screen have become

useful tools, these types of viewing information might cause a person to remember an image more or less than another.

Selective Attention. As an individual goes about their day, oftentimes they have to pick and choose what information is relevant instead of focusing on everything they see, touch, smell, taste and hear. Because not all of the information around them would be important for their immediate need, selective attention helps someone to select the necessary information that is needed for further processing while also suppressing the information that is not needed (Stevens & Bavelier, 2012). Especially in today's world, there are many activities that require selective attention such as walking down the street, browsing the internet and even playing video games. Because the brain is actively suppressing the information that is not necessary for the current task, it would make sense that advertisements are often overlooked.

When discussing interaction with an image or object, one of the most popular forms of the integration of these new skills of touch screens and hand-eye coordination come from video games. Similarly to looking at a screen or a video, a person can choose to focus on one part of the screen, not every tiny detail. So, how do you choose what to look at and what to remember? Oftentimes, it can help to examine the effects of video games on the way that a person is able to navigate through unknown terrain in a video game setting that might be different than real life.

As some studies have looked at the effect of video games on behavior (Baranowski, et. al, 2008), they have also started looking at the effect that video-games are having on visual attention (Green & Bavelier, 2003). When playing a video game, the environment is often constantly evolving and transforming, so being alert and having visual attention on multiple parts of the screen is important. Green and Bavelier (2003) investigated the way that video games affect

selective visual attention. The researchers used the flanker compatibility effect for their study, which measures the effect of a target that is supposed to be ignored. What prior research has found with this test is that when someone is doing a task that is easy, the distracter will have a larger effect, whereas when the task is more difficult, where someone needs to focus more of their attention on the task at hand, the distractor effect is smaller. This study used a distractor shape (either a square or a diamond) and while they were completing a task, participants had to say whether a square or diamond appeared in one of the six circles presented and the shape that appeared next to the circles could either be the same as the one in the circles or the opposite (it could be a square inside the circles and a diamond outside). What the researchers measured was the difference in time it took for the participant to say what shape was present when both of the shapes were the same and when the shapes were not the same. The more shapes there were in the six circles present, the more difficult the task was. When comparing video game players and non-video game players, they found that people who regularly played video games showed a flanker compatibility effect even when the task was hard compared to the non-video game players who showed the typical pattern of no flanker effect when the task became more difficult.

What this information indicates about the current platforms for advertising is that individuals who have grown up with video games and use them often, might be able to take in more information than many generations before. Because video games now contain so many different elements that cause a person to focus on many different parts of the screen at once, it helps with their processing of information that might not be directly apparent.

Divided Attention. Similarly to selected attention, often a person does not focus on everything that they see every second of the day. The person has to be able to pick and choose

what is directly important for them to be able to continue on with their life. Many people have started to claim that an individual's attention "span" is getting shorter. However, instead of looking at the amount of time someone is able to pay attention, it might be more important to look at how they are using attention to adapt to the constantly changing environment. This idea of focusing on more than one object at once is characterized by divided attention and often allows people to make sense of multiple parts of their environment at one time. But, when splitting attention, there can be consequences that might not allow the person to fully focus on all they are being presented with (Buchin & Mulligan). However, as long as the person is able, having a divided attention might not necessarily be a bad characteristic as long as an individual can focus on the two objects at once.

Buchin & Mulligan (2019) investigated the effect of divided attention on the encoding effects of retrieval. Their experiment had two different groups, one group that worked on divided attention (having to remember both words and numbers in the experiment) and another group that worked on focused attention (only having to remember words). In the first part of the study, both groups were given a set of words to remember and for both groups, there was no further distraction. However, in the second part of the experiment, the focused attention group was again given the words to remember without further distraction. The divided attention group was then given a distractor in between their first memory test of the words and the second test where they had to count backwards by 3 from a number given to them. In their second memory test of the words, they were given the words, but were also listening to random numbers throughout their recall and had to listen to the digits and press a button on the keyboard depending if they heard an odd or even number. The results from this study found that the differences in free-recall

words were significantly different between the full attention (focused attention) and divided attention groups during the restudy stage where the full attention group were able to restudy significantly more words on average than the divided attention group. However, this was not seen in the retrieval portion of the experiment where both groups were not significantly different from one another. This study found that when the participant had divided attention during the restudy of the words, it caused them to remember significantly fewer words than the groups that had no divided attention during the restudy. As this study showed, concentration on a specific object often affects the amount that a person is able to pay attention to the task at hand because as your brain is working to remember certain words, it is then hard for a person to immediately focus on another task. However, it also helps to indicate that regardless of if someone has divided attention or not, when first remembering something, a person on average will remember and be able to retrieve the same amount of information later on.

Connecting to advertising, often when people see an advertisement, that is not all that they are doing. Likely, if they are watching a television advertisement, they are also looking at their phone, or if they are scrolling on a newsfeed, there might be something else trying to grab their attention. With the results of the previous studies, they help to show that although individuals may not remember all they are shown, even with divided attention, they will probably remember some of what they are shown. This is why it is important to continually show the advertisements to convey information so that consumers remember more pieces of the information presented every time they see it.

Attention Grabbing. Companies try to get people to remember different types of advertisements, especially when the advertisement is trying to gain the attention of possible

consumers. One of the themes that is examined in grabbing attention is looking at the effect of moving advertisements on memory. Kuisma, Simola, Uusitalo, & Öörni (2010) studied the effect of moving objects on attention grabbing and memory recall. With so many images and advertisements cluttering pages, it is becoming more difficult for certain advertisements to stand out from one another and can cause consumers to just avoid them altogether (Cho and Cheon, 2004, Ha and McCann, 2008, McCoy et al., 2007). The researchers believed that the moving advertisements would attract more attention than the static advertisements. The participants were given several conditions with the different types of advertisements with various combinations of moving and static images on a page and they used an eye tracker to determine the effect of attention grabbing of the advertisement. The participants were also examined on how much they remembered the different advertisements and which ones were just attention grabbing vs. which advertisements were trying to relay a message. They found that animation had no real effect on attention in the experiment but they did find that animated skyscrapers (going up and down on the side of the page) were more effective in grabbing attention (meaning participants spent more time with their eyes focused on those areas) than animated banners (at the top of the page).

Similar to the idea of attention, memory is also becoming adapted with the constant use of technology. Research is becoming even more focused on the effects of technology and how the “unavoidable” internet is possibly causing us to change the way that we think and interact with the world (Firth et. al., 2019; Sparrow, Liu & Wegner, 2011). Even when not on a computer, cell phones have created the habit of “checking” the phone that might cause attention on other immediate parts of an individual's life to be subsidised (Wilcockson, Ellis and Shaw, 2018). Certain studies have actually found that there might be cognitive consequences for

constantly having information at our fingertips on a phone or tablet. Sparrow, Liu & Wegner (2011) found in their research that oftentimes, instead of remembering information that someone receives, many people will remember more about where they can find the information such as on Google or on a social media platform. In their study, they looked at if people were able to remember information that they knew they would have access to later on online. For the experiment, the participants were told 40 different pieces of trivia and were told to type them in a document on the computer. Half of the participants were told that what they typed would be erased and the others believed they would have access to it later. After having the participants type out specific pieces of trivia to ensure attention, the participants were then asked to write down all pieces of trivia that they remembered from earlier. The study found that the group that was told they would have the information later remembered significantly less facts from the experiment compared to the group that did not think they would have access later. Connecting to the current study, although something on the internet might catch attention, if someone believes that they will be able to access the information later, then they likely will not try to remember it. Whereas if they know that they probably will not be able to find it again without knowing basic information about the image or message they saw, there will be a greater likelihood that they will remember it.

Looking at memory in general, there is not simply one definition of "memory" because memory is used and stored in different contexts. Memory is often split up in different subsections, three of which are most important in this study. These subsections include short-term memory, working memory, and long-term memory.

Short-Term Memory. Many studies have looked at short term memory from a psychological standpoint. Short-term memory normally includes memory that happens in 30 seconds or less and then is often forgotten (Healy, 2001). What happens in many of the studies done by psychologists is they have found that if someone is given something to remember, but is not able to immediately rehearse or actively remember the word or object, the individual will likely forget what they saw in 30 seconds on average (Healy, 2001). Thinking about how this might relate to advertising, oftentimes there are several advertisements displayed at one time if looking on a laptop or cellphone. When scrolling down a newsfeed, without even thinking about it, a person is probably seeing a significant amount of advertisements, but most of them will be forgotten shortly after if they do not have any relevance to the individual.

However, if just looking at advertisements and not factoring in other parts of the web pages, studies have looked at what affects the capacity of short term memory. Alvarez and Cavanagh (2004) investigated how the capacity of visual short-term memory is impacted by visual information and the number of objects presented. In their study, they looked at different types of objects ranging from different shades and different colors. Although previous research suggested that only four objects were able to be remembered in a person's visual short-term memory (Vogel, Woodman, & Luck, 2001), the study done by Alvarez and Cavanah suggested that the amount of information someone remembers in their short term memory might have to do more with what they are seeing rather than just the number of objects. To test this, each person did a visual search trial where there was a target presented at the center of a screen for 500 ms that was then followed by a blank screen for 900 ms and then either 4, 8 or 12 objects were presented from the same stimulus. The stimulus categories included shaded cubes, random

polygons, Chinese characters, letters, and colored squares. In each of the trials, the participant had to say whether or not the target that was originally shown was present or absent. For each "change detection trial" the participant was shown 1, 5, 7, 9, 11, 13 or 15 objects for 500 ms and again followed by 900ms of a blank screen. For half the trials, the two displays were the same and in the second half, one of the objects changed slightly. The participant then had to indicate if an object had changed or not. The results indicated that in the target search, they found that there was little error in finding the targets and there was no true difference in the speed of finding the targets with the different objects. In the second task where the participant had to determine if the objects changed slightly, there was found to be a 75% correct threshold. This number came from the average of both the no change and the changed objects correct answers. However, this accuracy was different based on the different objects and stimuli meaning that the cubes were detected significantly more when they changed compared to the colored squares. The researchers found that the subjects remembered more of the colored squares than the random polygons or the Chinese letters.

This research suggests that the type of object might be the most important part of the visual short term memory. As someone sees advertisements or something to remember, it might be more important to include an object that they will remember more so than worry about including a certain number of objects in a single advertisement or lesson. It also suggests that the visual short-term memory might be better when looking at an object instead of a letter or character, which would help to suggest that images might be more memorable than words.

Working Memory. Although sometimes short-term memory can be used in working memory, working memory is described differently. As defined by Adams, Nguyen & Cowan

(2018), "working memory is a system of components that holds a limited amount of information temporarily in a heightened state of availability for use in ongoing processing" (p. 341). When thinking about the way that individuals interact with a lot of the information that they get everyday, there is also a lot of information that they do not remember. Therefore, it is likely that the information they do not remember is not needed to continue on with their life. If there is something that is important to an individual's functioning or is important in the moment, this would likely be used as part of their working memory.

Long-term memory. Lastly, long-term memory is also an important subgroup in memory because it helps to use your knowledge that you have consolidated throughout your life to make sense of what is going on around you. Long-term memory is similar to working memory because it helps you to use your knowledge and skills that you have been able to gain, which act more permanent in an individual's brain, although all the information might not be used at all times (De Bruyckere Kirschner, & Hulshof, 2015).

Long-term memory is essential when it comes to advertisements making an impact on the actual changes that are intended by a message in an advertisement. People have studied the impacts of different types of advertisements and which ones cause more people to consolidate the information into their long-term memory. Even before advertising began to change with the introduction of many technologies, advertising research was done to attempt to change the way that people saw advertisements. In one article, Ambler, & Burne (1999) looked at the impact of affect on advertising. The authors examined how the content of the advertisement and how much the person felt an emotional connection to it had to do with how much they remembered it long after they saw the video or image. In this study, the researchers had subjects watch a 24 minute

video as background about the ecology of rainforests and then they watched 6 minutes of advertisements that were in two groups of 4 TV advertisements. Each block was about the same amount of time as a commercial break (about 10 minutes into the show and 10 minutes later). Two advertisements for each brand were used and the advertisements were of well-known UK brands that were of goods and services, fast food restaurants, a retail bank, a beer, and an oil company. The presentation of the advertisements were switched for each group to reduce primacy and recency effects. 24 hours later, the participants were shown 100 images from the video that they watched and categorized them into ones that made them feel more or less emotional. In order to assess the longer-term effects, the participants were sent a questionnaire to fill out 28 days later that was the same procedure as when they were shown the first 100 images the day after the study. The results found that there was a correlation between the first day recall and the 28 day later recall, which indicated that the affective ads (ones that produced more emotion) were recalled better than the ones that did not have an emotional aspect. However, they did mention that just because affect is important in recognition, it is not the only factor in recall and it is different for everyone. Even though one person finds one advertisement to be emotional does not mean that all people will find it to be emotional in the same way.

In connection with the previous study, it is important to look forward, especially now with the introduction of many new forms of technology. Without that emotional component, the current study will look at how a simple interaction might cause people to remember an image especially because as the researchers suggested, not all emotional advertisements will affect people the same way and cause them to remember it longer. As it is always hard to know what

might be emotionally triggering for everyone, or the majority of people, is there another aspect of an image that can cause people to remember the image aside from emotions?

Engagement with Information

Before discussing the many ways that the positioning and manipulation of an advertisement can play a role on memory, it is important to understand what some people are remembering from the content of different messages. Specifically looking at warning messages, Maynard, Munafò, and Leonards (2012) investigated the effect of tobacco warnings on smokers and non-smokers. They looked at the questions of if novel warnings cause better recall than existing ones. They also asked if novel warnings attract and maintain visual attention better than the mandated ones. They found that the classic branded packs were more effective for recall than any of the newly branded ones with warning messages. The researchers believed the classic packs were remembered better because it was what the participants had been used to seeing and automatically associate them with the brand. Also, many of the participants shifted their gaze towards the warning. Although warnings might seem different from advertisements, they essentially do the same thing, try to gain the attention of people in the general public and get them to remember the information that is presented.

Another type of warning message that has been researched looks at alcohol use. Kersbergen & Field (2017) examined the effect that advertisements around alcohol and responsible drinking have on alcohol consumption in a lab setting. In this study, the researchers looked at a consumer's visual attention to TV alcohol advertisements and public health campaigns and how much the advertisements and campaigns would predict their drinking consumption. The participants were shown three types of images, one that was a public health

campaign, one that was a “drink responsibly” campaign and the last was just an advertisement for Heineken. They found that exposure to the public health campaigns did not have more of an impact on the individual’s drinking intentions compared to the “drink responsibly” alcohol advertisements. Even if an advertisement caught the eye and held the visual attention longer, it did not significantly change their behavior towards the alcohol. Therefore, this study did find that none of the images had any effect on how much an individual drank during the experiment. Even if the images did not change the actual behavior in alcohol consumption, there are many studies that continue to look at how to make someone remember what they see.

In connection to the studies on warning messages, the current study proposes that interaction with an image will cause someone to remember it more than if they simply viewed the image. In continuation with the previous research on how the warning messages affect behavior, there is the question of whether or not this study would have been more effective if the participants had to physically do something with the message they were given in order for them to not only remember it more, but also consciously think about it further.

One of the hardest parts about any type of advertisement, warning message or really anything that is supposed to be used to change behavior is that oftentimes even if someone sees the message, it does not change the way that they act. However, as with many advertisements using emotion as a key component, warning messages can do the same, especially with something as prevalent and debated as global warming. One study investigated how the emotional component in messages about global warming had an effect on actual responses about the issue. The study done by Smith and Leiserowitz (2014) sent out a survey around the country to represent a wide range of people on the topic of global warming and in the survey they were

asked to answer questions on their support or opposition of several policies on global warming that were supposed to lessen the effects. They also were asked on a likert scale if they believed global warming was a good or a bad thing. All respondents were then asked to provide an effective image of what came to mind when they heard the word "global warming" and in response to that, the participants then indicated whether the image they thought of was a good or a bad thing that was marked on the likert scale. Lastly, they were asked to rate emotions that they felt when thinking about global warming. What the study found was that most participants supported policies that tried to mitigate the effects of global warming and felt that there should be more research for renewable energies. They also found that with the emotional aspect, if the individuals were worried about the effects of global warming, then they were more likely to actually want to do something about it. However, they found that fear was not a large contributor to support in policy. Therefore, this study can help to indicate the type of emotion that might cause people to actually change their behavior, and this might not be fear which many studies have believed to be a large contributor to change. This is possibly because fear provokes the body in a way that might be counterproductive and might cause the body to feel the effect of the fight or flight reflex (Öhman, 2008).

New Platforms for Advertisements

When many people think of traditional advertising, they often think of advertisements on television, on the radio and in print (Dimitrioski, 2019). As more people are continually on their phones or computers, many advertisements are beginning to shift towards a new medium. The integration of touch screens has given an opportunity for more engagement with the actual advertisement than there has ever been before.

Laptops. Laptops evolved from the early desktop computers. As technology has evolved, the screens have become smaller and have allowed for a more mobile experience. Not only in workplaces, but also in schools, students are now encouraged to bring a laptop to do work in the classroom. It has become a tool that has been useful for learning, and allows individuals to take notes at a faster rate than ever before (Mueller, & Oppenheimer, 2014). However, with the increase of laptops in many classrooms, there continues to be a concern in the effectiveness of retention of information when a laptop can hold many distractions.

Fried (2007) looked at the effect of laptop use in a classroom on learning. The study used students from sections of a psychology class taught by the same professor to test this hypothesis. The research was conducted on a lecture class where students normally took notes, but at the beginning of the semester, the students were told that they could take notes on their laptop, but would never need their laptop for class. Each week, the students were given a survey to answer if they attended the class, if they used their laptop in class, and how long they spent doing things other than taking notes while in class on their laptop. The results found that over half the participants used their laptops in at least one class period, and when the students used their laptops in class, it was negatively correlated to the amount that the students reported they paid attention to the lecture. There was also a negative correlation between laptop use and how clear the students found the lectures and how much they felt they understood the material that was presented. Overall, the amount of time that students self-reported to be spending doing something other than taking notes for the lecture, was negatively affecting the way that they were able to learn and understand the information.

Other researchers have also looked at the effects of laptop use as it relates to note taking in a classroom setting. Mueller and Oppenheimer (2014) determined if taking notes on paper was more effective than taking notes on a computer. Previous literature has suggested that when people take notes on a computer, they are less likely to synthesize the information, and rather, just take notes that say exactly what they are told, which causes them to not remember the information as well (Bretzing & Kulhavy, 1979; Igo, Bruning, & McCrudden, 2005). When the participants came into the study room, they were either given a laptop or a notebook with a pen or pencil. The students were then given a lecture (a TED talk that was about 15 minutes long) and were told to take notes on the lecture without the experimenter in the room. The participants were then given a 5 minute distractor task and a working memory task in a different lab. After the distractor tasks, the participants were then asked questions about the lecture both factual-recall questions and conceptual-application questions. The study found that when asked conceptual questions, laptop users did significantly worse than longhand note takers, but the lecture they were given also affected their scores for both groups meaning that some lectures had a lower average for conceptual question answers than others. However, there were no significant results differentiating the groups when asked factual questions. In looking at the actual content of the notes, the people who took longhand notes wrote fewer words than the ones that took notes on the laptop, but just because there were more words, did not mean that they performed better on the recall. As expected, people who took more notes overall on the topics that were discussed did better on the task. However, in the notes, if the participant simply took verbatim notes without synthesizing what they were listening to, they did not perform as strongly on the task. Although this might not seem significant in the advertising field, many of the findings can also

be applied to further research on advertising. When it comes to conveying messages over a computer or on a screen, it is important to somehow have an element where the individual can synthesize or think deeper about what they are observing.

In the second study, they wanted to give students instructions on not to take verbatim notes and see if that made any difference. In this study, participants were given a similar task to the first study, but participants watched the lecture individually with headphones on and the non-intervention group was told to just take notes either on the laptop or paper. However, the group that had the intervention were told to not just write down every word that the person said, rather, they were told to write down the information in their own words. The students were then given a distraction test and were asked similar questions to the ones in study 1 that asked about the content of the lecture. What they found was that the laptop-intervention scores of the participants did not differ significantly from the laptop-nonintervention group and the longhand group. They also found that the laptop groups (both with the intervention and non-intervention) wrote significantly more than the longhand groups, and although there was instruction to not take verbatim notes, it was entirely ineffective in making it so that they were not writing down exactly what was said. The researchers found that those who were able to synthesize the information were able to do better at answering many of the questions that were asked.

When thinking about advertising and teaching in general, oftentimes a person is not expected to do anything with the information. They see the image or read it, and often do not synthesize it in their own words. Without some sort of interaction with the content, it would make sense that the majority of the advertisements that we see, we probably do not remember. But, to make the message come across more strongly, this could mean that to remember the

advertisement later on maybe it would be beneficial to write down something on a pen and paper or involve more than just sight to get someone to think about the meaning of the content. With advertising nowadays, this might not seem to make sense, however, there are still a significant amount of advertisements or messages that are in newspapers or magazines that could use this method. If you think of the ways that different messages might come across such as in a crossword puzzle or some type of game where a person is interacting with the information, using a pen and paper might be possible, and could be more efficient in getting the point across.

Especially when students in these studies are often distracted throughout class, it is important to find ways for them to interact with the information that a person is teaching in order for them to remember it better. Because they are used to seeing many different distractions as they are learning information, finding ways to channel that distraction to keep them engaged while sitting in a classroom could help to enhance their own studies.

Similarly to most technologies that can cause distractions, when trying to target individuals on a laptop, smartphone, or tablet, it is important to be strategic about what information is shared, and possibly where on the screen it is being shown. Because people are constantly viewing browsers on any sort of piece of technology, understanding what is the most effective way to convey pertinent information that can grab their attention can be an important tool for any company trying to target consumers.

Smartphones. Many people today are rarely seen without some sort of telephone or smartphone on them. The newest generation, Generation Z, *only* knows life with the internet and other technologies that are now seen everyday. However, the introduction of the smartphone was not too long ago. The first true smartphone was introduced when Apple created the iPhone in

2007 that allowed everyday individuals to carry around many functions of a computer, such as the use of the internet, with the ease of a touchscreen that could all fit in the palm of your hand (Jackson, 2018). With the introduction of the touch screen, smartphones changed the way that we are able to view and interact with the information we are given. From advertisements, to videos to text messages, there are more functions coming out in the world of the smartphone that makes finding new and exciting information even easier.

Since the introduction of the smartphone, the possession of this technology has increased dramatically. One article written in 2019 by J.M Twenge indicated that over 95% of teens have access to a smartphone and many said they are online "almost constantly" (Anderson & Jiang, 2018). With this increase in technology usage at a young age, many teens also reported not reading as much especially books and magazines (Twenge, Martin & Spitzberg, 2019), which is why it seems the shift in advertising has changed so dramatically over the past few years to focus on online platforms.

However, with this new technology comes new challenges. Phones have become a distraction during many activities such as driving, studying and more that can negatively affect someone's life. Smartphone addiction, or the constant distraction and need to use a cell phone, has become a challenge that many psychologists have been trying to understand. Swar and Hameed (2017) found that many individuals have become addicted to their phone in a way that has never been seen before where addiction was measured in how much someone cannot go without checking their phone, they get nervous when they do not have their phone etc. These negative effects of the addiction are that an individual might not be able to control the impulse to be on their phone or to have their phone constantly by them. The study split the participants up

based on if they had any sort of self-help applications on their phone to try to cut down on their smartphone usage. The other group did not have any sort of application to monitor their usage or behavior. The results of this study found that on average, the participants who had self-help applications reported high correlations with being able to regulate the amount of social media addiction, engagement, distraction and addiction to the device itself. This study also found that people who had higher psychological needs also spent more time on social media because of a reported "fear of missing out".

The increased distractions that are caused on a phone are both good and bad for the individual, but it also gives more of an opportunity for companies or advocate groups to get information across to more people. With a more conscious awareness of people trying not to be on their phones as much, the way that advertisements have to be effective in the limited amount of time some people may be spending on their phone may make it harder for messages to get across. Especially because if it seems like there is something that is not worth the person's time on their piece of technology, an individual may look away from a screen or do something else while an advertisement is playing to limit their screen time. However, the other side of this is that with the increased usage of these devices, an individual also sees a lot of information that they might not remember because of the constant scrolling through a news feed to make sure they have the most up to date information from their friends.

Tablets. In looking at the everyday usage of laptops, smartphones and tablets, it is clear that there are both pros and cons in using the technology. However, as we are constantly using these technologies, it is important for everyday individuals to be able to figure out how to best

use them to help themselves. From distractions, to helpful tools, there are difficulties that come with using each of these platforms.

In the classroom, iPads have become used even more because of the ability for students to interact with the information that they are given especially when starting with memorization and practicing creating words that help to create a more fun way of learning about many fundamental skills. Kucirkova (2014) observed the effect of iPads on early learning. Although there seem to be many positive effects of using iPads in an educational setting, there also could be some false information as to whether it is entirely better or worse than traditional forms of teaching. There is also a lot more study that has to be done on the effect of iPads on learning in general, as it is a relatively new medium for teaching that has been linked to promising results, however, there have mostly been correlations or studies without doing experiments to see the true differences in many applications. When iPads first surfaced in schools, there was a notion that all types of learning would be done better if on a surface, however through Kucirkova's research, this may not be the case such as in the comparison of reading comprehension on an iPad and in print. In further research on the impact of iPads on learning there have been studies that have demonstrated the effects of learning math skills by using iPads especially in students who are not given the proper resources to succeed in certain subjects on their own or through the teachings that they are given.

In-Game Advertising. Beyond many forms of typical advertisements, in-game advertising is becoming increasingly popular, especially among the individuals that play them most frequently. Because of the amount of time that is spent playing video games, companies have started to take advantage of this new outlet. This type of advertising appears when brands

will insert themselves somewhere in the video game, although, it might be subtly in the background of the actual game being played.

One study investigated how this type of advertising might have an effect on a college student's implicit memory, information that is not consciously remembered, and explicit memory, information that you have to consciously remember, (Spataro, Rossi-Arnaud, & Mulligan, 2017) of that advertisement. One study looked at video and computer games and their effectiveness of in-gaming advertisements. To subtly advertise for certain companies, brands can incorporate their logo with a specific character in a game such as through their uniforms or equipment in sports games (Nelson, Keum, and Yaros, 2004). The study (Yang, Roskos-Ewoldsen, Dinu, & Arpan, 2006) examined two different games (a racing game - EA's Formula 1 2001 and a soccer game- EA's FIFA 2002) and looked at two independent variables (implicit and explicit memory). The participants were given a questionnaire asking about their previous video game experience and then they were told how to play the game on an instruction list. Participants were instructed to play the game for 20 minutes which allowed the researchers to know that all brands had been shown. At the end of playing the game, the participants were given a few questionnaires to "clear" their short term memory before giving them a word fragment completion test that was used to test their implicit memory, however they were told that it was a word game and were not told that it had anything to do with the video game. After the word fragment completion test, they were shown the brand names that had appeared in the video, and they were told to indicate whether they had seen the brand or not. As a result, the racing game had significant results indicating that participants recognized the brands that appeared in the game more than just by chance. This was also true for the soccer game. This study did not

find any significant results for implicit memory from the word-fragment completion task for either game.

This new type of advertising can pair video game characters to certain types of clothing associated with the character that many players become familiar with. Even though the players might not actively think about the tactics being used to target their consumer mindset, they are interacting and often making conscious choices in what brands they want their character to wear, especially when it comes to sports games.

Measures Used in Many Studies

Although the current study does not use the Eyelink 1000, it is important to know of the tools often used in this type of research. Especially because the Eyelink 1000, creates a heatmap of the page, it makes it easy to see which types of advertisements automatically grab attention.

Tracking Eye Movements. When it comes to receiving important information, it is also important to figure out where people look in the first place to get that information. Although the current study does not plan to use a heatmap, this tool is another significant piece of equipment to gather information on how someone immediately views information on a screen. Many studies have used the Eyelink 1000 to determine where an individual may look on a screen depending on what is shown. One study in particular used the Eyelink 1000 to gain insights into the preferential view of nutrition information on boxes. In this study, Graham and Jeffery (2011) found that often, important nutrition facts are not as prominent as they should be, which could be contributing to the poor diets seen in many consumers. In order for companies to make the labels easier to see and understand to benefit the health of the consumers, the researchers proposed that depending on the location and label components, the consumers would be able to understand the

nutrition facts better. The study found that the parts of the nutrition label on the top of the label were viewed more than the bottom. They also found the labels that were positioned in the middle of the screen were viewed more than the ones on the sides. Therefore, eye tracking data in this study was able to help figure out an even better way to alert people of the nutrition of the food they incorporate into their diets.

There have also been studies using the Eyelink 1000 that have incorporated more traumatic experiences with different images. Kimble, Fleming, Bandy, Kim & Zambetti (2010) investigated the effect that threatening and non threatening images have on the eye movements of veterans from the Iraq war. The researchers wanted to investigate the relationship between hypervigilance, paying increased attention to a threatening stimuli compared to neutral stimuli, which is a key symptom in post traumatic stress disorder (APA, 2000) and how their eyes react or focus on the different stimuli. The study used 19 veterans of the Iraq war from Norwich University. The study then used a split screen which had one picture on each side (two pictures per slide). The participants were shown twenty slides total. For each slide, one picture was related to some part of the war and the other side had some sort of neutral image. The Eyelink 1000 was able to track the pupil diameters throughout the study and also detected where the participant was looking for each slide. The researchers found that the participants that had higher PTSD scores had larger pupils, indicating the activation of the sympathetic nervous system (“fight or flight”) and looked longer at the negative war images. Also, the participants with higher PTSD scores tended to look first at the negative war image before looking at the neutral image.

Both of these studies have used eye tracking to determine where a person looks when they immediately view an image, and it also shows that the placement of an image or important information is often determinant of how a person will view the image such as when looking at the nutrition facts. Because of the constant information that an individual gets throughout their day, it is often harder to convey information that might be crucial to a product or object. When discussing the current study, there are many components of attention that might affect what parts of an image or advertisement are remembered by an individual.

Reasons for Further Study

According to the previous research listed, attention and memory when it comes to advertising is becoming a greater topic of interest. Studies have looked at how "classically branded" items are often better recalled than newer ones. They have also found that when a person sees an advertisement or warning message, if they feel a sense of worry compared to fear, they are more likely to actually take action.

When it comes to actually grabbing attention, many researchers have found that sometimes it is the more subtle ways of conveying the information such as in a game format where the person in a video game is actually seeing the advertisements on the characters that might cause them to associate the character with the brand. Also, with many advertisements that try to pop out by moving or flashing lights, studies have shown that these might actually be ignored more than ones that are stationary.

However, with so many new platforms for advertising that use touch screens, it is important to understand how these might play a role in the way that individuals remember information. Therefore, the current study will incorporate a more interactive form of looking at

images and words in advertisements. Because of the increasing use of touch screens with smartphones, this study will be new in looking at the way that an individual will remember an image based on the way that they are instructed to interact with it. This could be with swiping or tapping or viewing, which are all movements that many people, especially people in Generation Z, use on a daily basis. Also, in the second part of the study, we will try to mimic the movements of objects in real life on a touch screen. Often when an individual interacts with an image on a screen they do not actually think of it as something they would do in their day-to-day life such as flipping a switch or moving a car, which might be different from an image that should not move in the first place. Incorporating images that a person would use on an everyday basis as part of a memory test has not been done before. The study will help to determine if the way that an individual interacts with the screen based on what they are commanded to do will have any effect on how well they are able to remember the image. This is different than past studies because most of the time, listening to a command or sound in general is not used in advertising unless it is a video, but it could show that incorporating multiple senses could create a difference in how people remember what they see. Lastly, another portion of the study that will be different is in looking at how people remember images based on the way they originally interact with them. For example, many studies have just asked what the individuals remember, but they rarely will ask for them to remember it in the same way that they learned the information, such as by tapping or swiping in the same way they originally learned the information.

Similarly to the way that people have been shown to remember more when they learn and synthesize information, interacting and then recalling objects in the same way, will help

determine if one way of interaction will create more effective learning in both advertising, warning messages and classroom settings.

Hypotheses

In the first study, there are multiple hypotheses that will be examined.

H1a. Participants will remember more images that they swipe, rather than tap.

H1b. Participants will remember images better when they hear a command rather than when they read it.

In the second study there are also multiple hypotheses that will also look to examine the effect of how an individual's memory might be affected by the way that they recall information.

H1. Participants will have to synthesize information about how an object moves in the swiping portion of the experiment, and therefore, they will take longer to respond compared to any other condition.

*H2*a. Participants will remember the images that they swipe on during recall compared to those that they view.

H2b. Participants will remember the images that they swipe during recall compared to those that they tap.

Method

Experiment 1

Participants

The participants of the study were 27 college students from the subject pool at Connecticut College. The students found the study through the SONA program and they were all given course credit for a psychology class for participating in the study. The majority of

participants were between the age range of 18-21 years old with the total range being 18-45 years old. The average age of the participants was 19.97 years old, and the majority of the participants were 19 years old. There was a fairly even split of male to females with slightly more females (55%) than males (45%). The majority of the participants were white (76%) compared to any other race. Lastly, as expected, because of the criteria for the study, most of the participants were right-handed (93%), however, there were a few participants who were left-handed, but had to use their right hand for the reach tracking in the study.

Materials

Hand tracker system. (See Figure 1) Methods were adapted from the Moher & Song, 2013 paper that described the system as follows,

> Stimuli were presented on an upright Plexiglas display facing the seated participant at a distance of approximately 48 cm. A projector behind the display projected the images onto the Plexiglas. An electromagnetic position and orientation recording system (Liberty, Polhemus) was used to record the three-dimensional hand position at a rate of approximately 160 Hz with a measuring error of .03 cm root mean square. A motion-tracking marker was fastened to the tip of each participant's right index finger using a Velcro strap. A Styrofoam block was placed 27 cm in front of the participant, between him or her and the display. This was the starting block on which participants rested their index finger at the beginning of each trial. Stimulus presentation was conducted using custom software designed with MATLAB (Mathworks) and Psychtoolbox (Brainard, 1997). (Moher & Song, 2013, p. 189).

Demographics Questionnaire. The demographics questionnaire (See Appendix E) asked participants about their race, ethnicity, gender and handedness.

Procedure

Participants found this study on Connecticut College's research participation system (SONA). When the participants came into the lab, they were instructed to fill out the consent form (See Appendix A) and demographics questionnaire (See Appendix E) before starting the hand-tracking portion of the experiment. The researcher then instructed the participant to put the hand tracking sensor on their right index finger and put their hand in the starting position on the table. The researcher then instructed the participant through the calibration process for the hand tracker by holding their finger on specific dots on the screen before hearing a beep.

After the calibration was set, the participant was shown a screen that said "For this portion of the study, you will be shown a series of images. For each of the images, you will be told either to swipe or tap the image in order to move onto the next image. The instructions to swipe or tap will be either told to you or shown on the screen before the image." In this first part of the study, the participants were shown a random set of images from the "Unique Objects" (Brady et. al., 2008) image bank (See Figure 3), but before being shown each image, the participant would hear a recording saying "tap" or "swipe" or they would see the words "tap" or "swipe". What they were told to do to the image before it was displayed was considered the "cue type" and the action they did was the "interaction type". Throughout the first part of this experiment, both the type of movement and the format of the cue (audio vs. visual) were randomly chosen for each trial. For example, the participant might see the word "tap" for one image and the next image they would hear on the audio recording "swipe". In total, the

participants were shown 120 of the random images in the first block that they interacted with. In order to advance to the next image after the participant touched or swiped the image, they had to make sure to return their finger to the starting position.

In the second part of the study after all the interaction was over, the participants were told to use the keyboard and use the “Z” key to indicate that they had not seen the image, and the “M” key to indicate that they had seen the image. However, there was no feedback to indicate if they responded correctly for each image. Going into the experiment, participants were not explicitly told that the first part of the experiment was part of a memory test, to avoid them actively trying to remember all the images, or picking ones they knew they could remember. During this block of the experiment, the participants were shown all 240 images from the image bank to see which ones they remembered.

At the conclusion of the experiment, the participants were shown the debriefing form (See Appendix C).

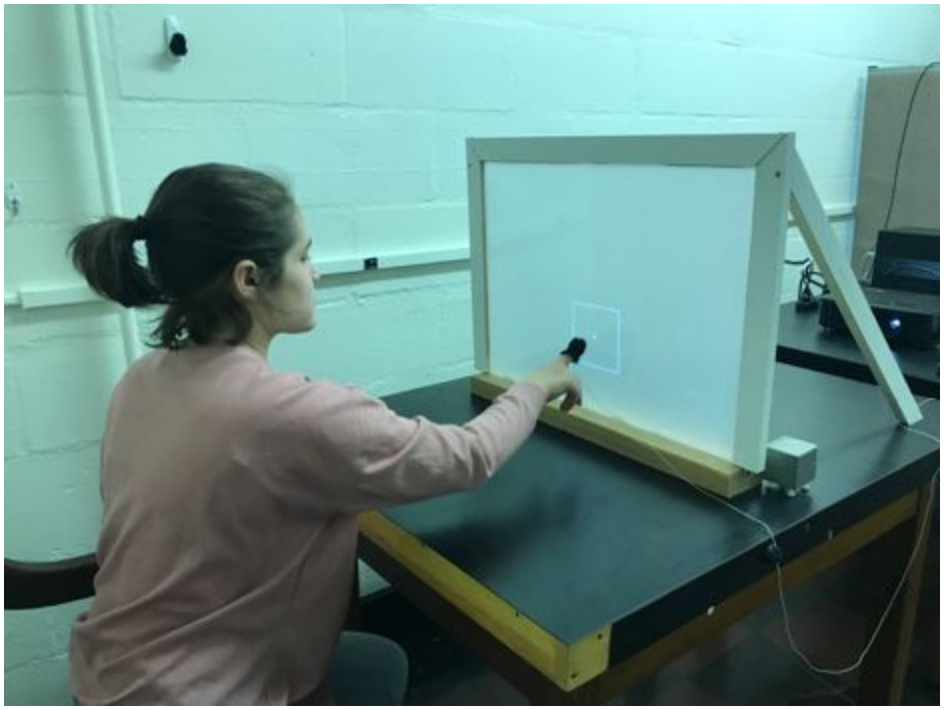

Figure 1. Lab setup of Experiment 1 and 2. The participant is wearing the sensor that helps to track the hand movements, and also was what allowed the images to advance when the participant swiped or tapped, similar to a touchscreen.

*Note. This picture was taken during another study, and therefore, the stimuli presented is not what was used for the study outlined in the current experiment.

Results

A 2 (Touch vs. Swipe) X 2 (Voice vs. Text) repeated measures ANOVA was performed to examine the effects of different types of interaction with an image on memory. Unfortunately, hypothesis 1a that swiping versus tapping would be remembered better was not supported, $F(3, 24)=1.501$, $p>.05$. Hypothesis 1b that said voice commands would cause better memory recall than visual ones was also not supported, $F(3,24)=.001$, $p>.05$. All conditions had similar results when it came to the accuracy of remembering the random images. The mean accuracy overall in each condition did not vary enough to cause a significant effect. The results found that the mean accuracy for the group of images that had the audio recording and were told to touch had a mean accuracy of .46 which was similar to the images where the participants heard the command and were told to swipe ($M=.48$), the images that participants were shown the word "swipe" ($M=.48$), and the images where participants were shown the word "touch" ($M=.49$), the insignificant results of all cue types on accuracy had a significance level greater than .05 (See Table 1). There was also no significant interaction between the command and the type of interaction, $F(3, 24)=.594$, $p>.05$. The accuracy in this experiment was low, but the correct rejection rates for when the participant saw an item they had not seen before and correctly indicated that they had not seen it was high ($M=.82$, $SD=.185$). This is evidence that the participants were actually retaining some of the information of images to indicate which ones they had not seen and therefore, they were likely not simply guessing, rather, they were not as successful at indicating which images they had seen.

Further analysis was conducted to look at the memory accuracy of the photos shown at the beginning and at the end of the first part of the experiment. A paired sample's t-test was

conducted. Significant differences were found indicating that the image that was shown first (*M*=.556, *SD*=.51) was remembered significantly less than the image that was shown last (*M*=.81, *SD*=.396), $t(52) = -2.096$, $p<.05$.

Lastly, the differences in response time were also analyzed for all trials and interactions. A two-way repeated measures ANOVA was conducted to compare the effect of cue type and interaction type on response time. Overall, there were significant differences between groups when looking at response times. The results found that there was a significant effect of cue type on response times between groups, $F(1, 26)=18.153$, $p<.05$.

The results found that there was not a significant effect of cue type within subjects on response times $F(1, 26)=1.757$, $p>.05$. However, there was a significant effect of interaction type (swiping versus tapping), $F(1, 26)=29.187$, $p<.05$ indicating that swiping (*M*=1.217 S, *SD*=.48 S) took significantly longer than the tapping condition (*M*=.936 S, *SD*=.393 S). There was also a significant interaction between cue type and the interaction type (See Figure 2) meaning that although the swipe condition decreased in response time when someone was given a visual cue (*M*=1.217 S, *SD*=.48 S) compared to the audio cue (*M*=1.12 S, *SD*=.322 S), the tapping condition took significantly longer with the audio cue (*M*=.971 S, *SD*=.493 S) compared to the visual cue (*M*=.936 S, *SD*=.393 S) $F(1, 26)=5.132$, $p<.05$ (See Table 2).

Table 1

Accuracy Means and Standard Deviations (Proportion Correct) for Cue Type and Interaction

Cue and Interaction	M	SD
Swipe Audio	.475	.186
Swipe Visual	.483	.179
Tap Audio	.462	.184
Tap Visual	.495	.166

*Note. M=Mean. SD=Standard Deviation.

Table 2

Paired Samples T-Test Results for Cue Type and Interaction Response Time

	Tap		Swipe		
Cue	M	SD	M	SD	t-score
Audio	.971	.493	1.12	.322	5.54**
Visual	.936	.393	1.217	.48	3.113**

**p<.05.

*Note. M=Mean (Seconds). SD=Standard Deviation (Seconds).

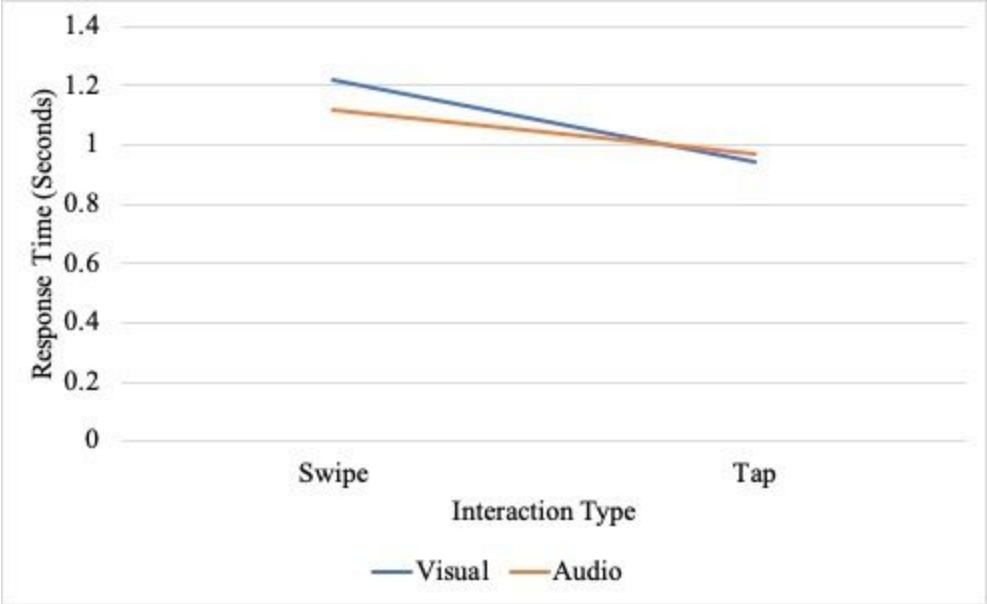

Figure 2. Interaction of response times (seconds) by interaction type and cue type

Discussion

The results from the first experiment indicated that when it comes to memory, people do not remember an image more based on if they are told to swipe or click on the image. Their overall accuracy in recollection was similar across conditions, which could indicate that the act of swiping or tapping was focused on more than thinking about the image itself. There was also no difference in accuracy when it came to instruction, but because the instruction came so fast with only one word, it might not have been a long enough instruction to have made a difference in their accuracy.

When looking at the differences in response times, there were significant results that indicated swiping took longer than tapping. Although there were significant results, this was expected based on the setup of the experiment that allowed for the action of the participant to dictate the amount of time it took for the picture to move on instead of having a set time put in place for all images. However, when thinking about when someone might swipe and tap on a digital platform in their own lives, swiping would likely take longer than tapping in all forms, not just in this experiment.

Another part of the experiment that could have caused the results to not be significant is the number of images that were given to remember for each participant. The length of the first stage of the experiment included 120 images and by the end, the participants mentioned that they were getting fatigued. Especially in the second part of the study that included all 240 images, the participants were simply instructed to press keys through each image to see if they remembered the images, however, throughout that entire time, the participants were not given any feedback as to whether they were correctly answering or not. Therefore, there might not have been an

incentive for them to actually try to remember the images compared to clicking through without thinking. This was seen with the low accuracy percentages across all conditions in the first experiment such as when cued with audio to swipe (*M*=.48) and tap (*M*=.46), and also when visually cued to swipe (*M*=.48) and tap (*M*=.49).

Lastly, the participants were also not told that they were going to have a memory test based on the first images. Because of this, many of the participants could have just swiped or tapped through and might have thought that the study was trying to measure response time instead of accuracy.

Based on the results from the first experiment, one of the major changes that will be implemented is limiting the number of images or splitting them up so that there is less participant fatigue in doing the same motion repeatedly. Also, in the second experiment in order to really determine if memory is enhanced when people interact with images differently, telling people that they will have a memory test at the end will hopefully prevent them from simply focusing on the action instead of the image. The second experiment will include feedback beeps in the recall portion of the experiment to prevent people from simply clicking through without any sense of what they are remembering and what they are not.

As a continuation from the results of the first experiment that did not show a difference between swiping or tapping and audio versus visual cues, the second experiment will focus more on the interaction with the image that makes more sense with what the image is showing such as a picture of a light switch that moves up and down.The other major part of the second experiment will be the addition of using the same interaction in both the learning stage and the memory portion of the experiment. According to previous research, individuals tend to

remember information better when they learn it in the same way that they are instructed to remember it (Godden & Baddeley, 1975). Based on the research, this would help going forward in the second experience to allow participants to remember images by doing the same action as was done when first seeing the image.

Methods

Experiment 2

Participants

The participants of the second study were 26 college students from the subject pool at Connecticut College. The students found the study through the SONA or through inquiry about the study. Participants were either given course credit for a psychology class or a $5 gift card if they were not in a psychology class for participation in the study. All participants were between the ages of 18 and 22 years old. The average age of the participants was 19.19 years old and the majority of the participants were 18 years old. The split between males and females was sided more towards females (65.4%) compared to males and (30.8%) and gender variant (3.8%). The majority of the participants were white (69.2%) compared to any other race such as Asian (19.2%), black (7.7%) and black and white (3.8%), and the majority of the participants were not hispanic or latino (84.6%) compared to hispanic or latino (15.4%). As expected, because of the criteria for the study, all the participants were right-handed. Lastly, almost half of the participants had corrected-to-normal vision (42.3%) compared to normal vision (57.7%).

Materials

Hand tracker system. (See Figure 1) We used the same methods for tracking hand movements as Experiment 1.

Demographic Questionnaire. The demographics questionnaire (See Appendix E) asks participants about their race, ethnicity, gender and handedness.

Procedure

In the second study, participants found the study on Connecticut College's research participation system (SONA) or through an inquiry about the study if they were not in a psychology class. The study was also titled "Advertising Preference" to prevent people from taking the study if they took the first one. When the study was up on SONA, participants were able to select it to sign up. Students were also able to see a date and location where they must report for the study. When the participant arrived at the lab, they were instructed to sign a consent form (See Appendix B) before starting the experiment. After signing the consent form, the participant also completed the demographic questionnaire (See Appendix E).

Similarly to the first experiment, the participants swiped and tapped, or viewed images, however, the images presented either had a type of movement such as a light switch that would move up and down or a car that might move left to right, or the image would have no movement associated with the object such as a stuffed animal, a box or a pencil. All images were taken from the "Unique Objects" (Brady et. al., 2008) image bank (See Figure 3).

The experiment had 3 different blocks. One block had all images with some sort of movement where the participants were given instructions to swipe the image in the direction of movement. The second block instructed the participants to tap through the images using their finger. Lastly, the third block instructed the participants to watch the images without touching the screen and there was an allotted time of one second given to each image that would automatically switch as the participant watched the image. The one second was close to the time

that it took for the participants to tap through the images in the first study. The blocks were randomized for each participant meaning that some participants were given the swipe block first and others were given the tap or view block first. For each block, there were a total of 40 images that could have been used out of the 80 images total in the image bank for each block.

Before the start of the experiment, the participants were explicitly told that the first part of the experiment was part of a memory test, which was a change from the first experiment. In the second part of the study after the different interactions had occurred with the images in the three different blocks, the participants were asked whether or not they remembered images that were shown. The memory portion of the experiment was also randomized and each of the three blocks contained 40 of the 80 images. In the memory portion of the experiment, participants were told to recall the images in the same (or similar) way as they had learned them. This meant that when the participant was told to swipe on images in the beginning, during the swipe block in the memory portion they swiped if they had seen the image and pressed the "Z" key if they did not remember the image. This was repeated for the "tap" and "view" block. In the "view" block, the participant simply used the keyboard and pressed the "Z" key if they had not remembered seeing the image, and they pressed the "M" key if they remembered seeing the image.

Another change from the first experiment was that during the memory portion of the experiment, there were feedback beeps that indicated if the participant chose the right answer.

At the conclusion of the experiment, the participants were given a copy of the debriefing form (See Appendix D).

Random image from the “Tap” condition

Random image from the “View” condition

Random image from the “Swipe” condition from experiment 2 with an element of movement

Random image from the images shown in experiment 1 without movement

Figure 3. Examples of the random objects stimuli shown in Experiment 1 and Experiment 2

Results

A one-way repeated-measures ANOVA was conducted to compare the effect of cue type on the accuracy of remembering an image in swipe, tap and view conditions (See Table 3 and Figure 4). The results found there was a significant effect of the interaction type, $F(2, 24) = 8.08$, $p<.05$. Three paired samples t-tests were conducted to make post hoc comparisons between conditions (See Table 4). The first paired samples t-test supported hypothesis 2b and indicated that there were significant differences between the accuracy of the swipe condition ($M=.899$, $SD=.063$) and the tap condition ($M=.825$, $SD=.132$), $t(25)=3.23$, $p<.05$. This meant that the accuracy of recall in the swipe condition was significantly better than the touch condition. Hypothesis 2a. was also supported indicating there were significant differences between the accuracy of the swipe condition ($M=.899$, $SD=.063$) and the view condition ($M=.85$, $SD=.084$), $t(25)=-2.77$, $p<.05$. Similarly to the swipe and touch condition, this also supported the hypothesis that the swipe condition would cause people to remember more images than the view condition. However, there was not a significant difference in the accuracy of the touch condition compared to the view condition.

The effect of interaction type on response time was also examined by conducting a one-way repeated-measures ANOVA. The results found that there was another significant effect of interaction type on response time, $F(2, 24) = 77.675$, $p<.05$. To examine the differences between the response times with different interactions, three paired-sample's t-tests were conducted (See Table 5). The first t-test compared the swipe response time and the tap response time. The results found that there were significant differences in the response times, supporting the first hypothesis that participants have to synthesize the information of an element of

movement and therefore, they will take longer to respond compared to any other condition. This was found where the swipe condition took significantly longer (M=2.11 S, SD=.568 S) than the tap condition (M=1.72 S, SD=.95 S), $t(25)=3.474$, $p<.05$. A second paired-sample's t-test compared the tap response time and the view response time. The results found that there were also significant differences between the two groups where the tap condition took significantly longer (M=1.719 S, SD=.95 S) compared to the view condition (M=1.00 S, SD=.00 S), $t(25)=3.856$, $p<.05$. As stated previously, the view condition did not have any variation in the response times between participants because the experiment had a set time of one second for the view condition images before they automatically changed. Lastly, the swipe response time and the view response time was compared in a t-test. The results indicated that the swipe condition took significantly longer (M=2.11 S, SD=.568 S) than the view condition (M=1.00 S, SD=.00 S), $t(25)=9.975$, $p<.05$ (See Figure 5).

Table 3

Accuracy Means and Standard Deviations (Proportion Correct) in Experiment 2 for all Interaction Types

Interaction	M	SD
Swipe	.899	.063
Tap	.825	.132
View	.85	.084

*Note. M=Mean. SD=Standard Deviation.

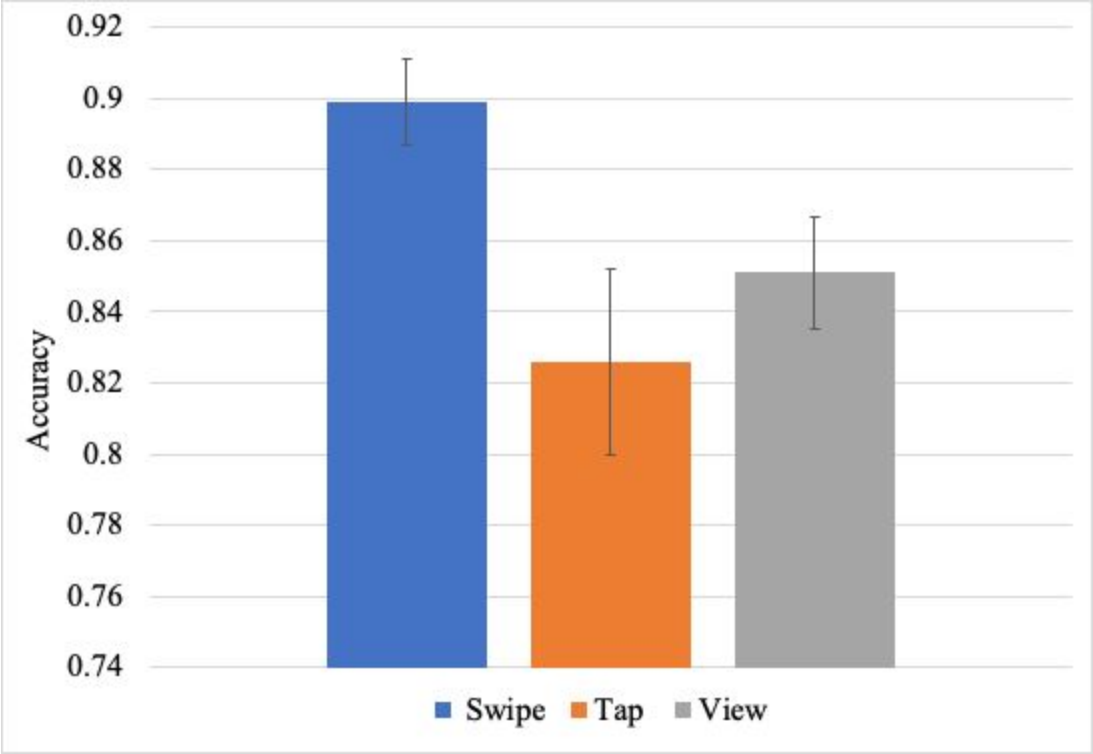

Figure 4. Accuracy means by interaction type in Experiment 2

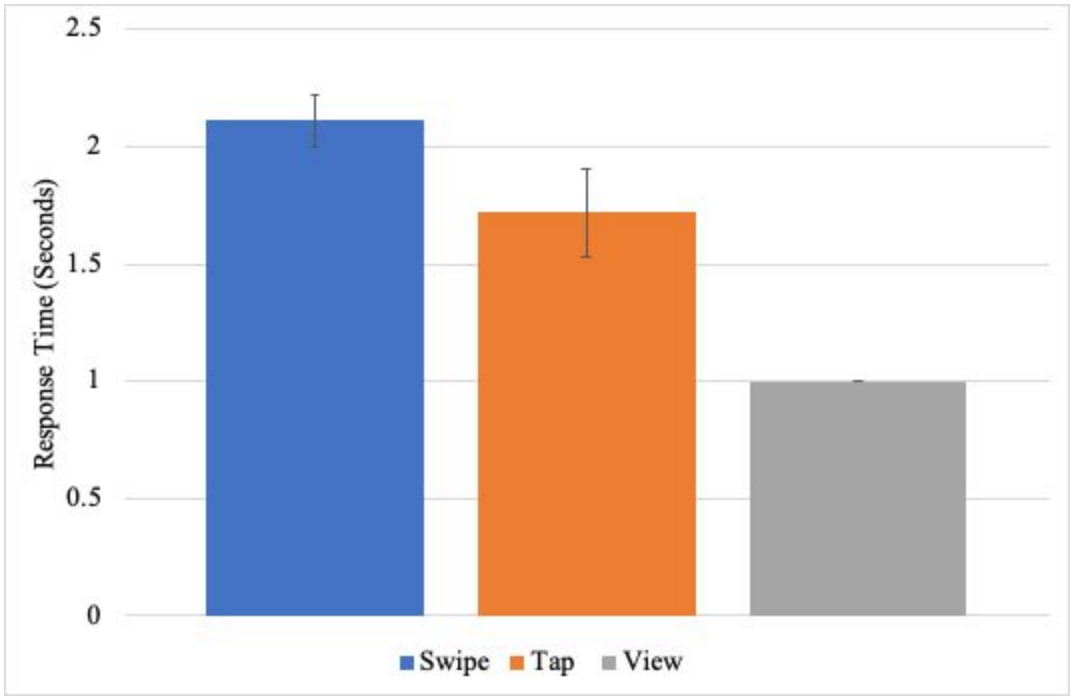

Figure 5. Response time means in Experiment 2 for all interaction types

Table 4

Paired-Sample's T-Test Accuracy Results Means and Standard Deviations for Experiment 2

Interaction	M	SD	t
Swipe-Tap	.074	.116	3.226**
Tap-View	-.025	.141	-.903
View-Swipe	-.049	.089	-2.77**

**p<.05.

*Note. M=Mean Difference. SD=Standard Deviation.

Table 5

Paired-Sample's T-Test Response Time Results Means and Standard Deviations for Experiment 2

Interaction	M	SD	t
Swipe-Tap	.392	.575	3.47**
Tap-View	.719	.950	3.86**
View-Swipe	-1.11	.568	-9.98**

**p<.05

*Note. M=Mean Difference (Seconds). SD=Standard Deviation (Seconds).

Discussion

The results from this study supported all three hypotheses stated before the start of the experiment. The first hypothesis was supported looking at the response time in the swipe condition compared to any other condition. With the instructions to respond with a swipe in the direction of movement, even if it may not have been intuitive, it made sense that this condition took longer than any of the others where there was not much thinking.

The second hypothesis was also supported in this study, which hypothesized that the participants would remember the images better in the swipe condition compared to view condition. The data showed that participants responded more accurately in the swipe condition than any other condition, which also supports the third hypothesis that swiping would be better than tapping in accuracy.

There are a few reasons that this experiment could have been more successful at getting significant results than the first one. One reason could be that doing the same action during recall as a person does during the learning stage helps to retrieve the information more efficiently, therefore, that would make sense why the mean accuracy across conditions was higher than in the first experiment. There were also less images in this experiment compared to the first experiment, which could have led to not only less participant fatigue as the experiment went on, but also could have caused a greater memory capacity. Lastly, this experiment, compared to the first, told participants that there would be a memory test at the end, so actively remembering the images was part of the process instead of focusing solely on the interaction.

General Discussion

In Experiment 1, we found that there was not a significant difference in accuracy between swiping and tapping when participants were given a memory test that did not involve further interaction with the image. It was also found that the cue type of visual versus auditory did not cause any difference in accuracy. However, when examining response times, it was found that swiping took significantly longer than tapping, and there was a significant interaction between cue type and interaction type. This indicated that when participants were given a visual cue, their response time was longer than the audio cue when they were told to swipe on the image, however, when the participants were told to tap on the image, the visual cue response time was shorter than the audio cue.

In Experiment 2, we found that there was a significant difference in memory accuracy between the three different conditions (swiping, tapping and viewing). It was found that swiping was significantly better in accuracy compared to both tapping and viewing when the same interaction was used for the memory portion of the experiment. It was also found that when looking at response times, swiping took significantly longer than when people tapped or viewed (with the set time of one second).

Based on the results from the data in both experiments, we found that swiping not only takes longer than tapping, but it caused better accuracy when recalling which images had been seen compared to tapping or simply viewing the images. However, this was only true when swiping was also a part of the recall phase. Another important distinction between the two experiments was that in the second experiment, the images had some type of movement or direction of movement in the image that was intended to cause the participants to think a little

more about why they were swiping instead of simply swiping because they were told to. When using the same action during recall, it may have caused the participants to more accurately decide if they remembered the images or not.

The hypotheses in the second experiment were all supported and focused on the idea that swiping would not only take longer if participants were thinking about the movement, but also the act of swiping and the consolidation of the information could have caused them to more accurately remember the images.

There are many reasons that these results could have occurred. In the first experiment, there were many more images that were shown compared to the second experiment. This could have caused the participants to feel more fatigue when looking at the images in the first experiment. There was also more information for them to remember going into the memory portion of the experiment. With this increase of images, it could have made the participants think that they had seen even fewer of the images than they really had, also leading to the insignificant results between the two interactions. Also, without using the same movement in the recollection portion of the experiment it could have made it harder in general for the participants to remember based on how they had learned the images, especially because the participants were instructed to do the action without a purpose.

The other part of the experiment that might have made it harder for the participants to remember the images from the first portion of the experiment was that the images were all simply random. Many of the images were objects that the participant likely had never seen before, so remembering something that is completely new could have caused them to forget it more easily. These images also had no relation to the action that the participant was instructed to

do. For example, one of the main differences that changed from the first experiment to the second was separating the images by the type of movement associated with the image.

Lastly, response times could have been significantly longer in the swipe condition simply because of the way that the experiment was set up. Without having a set time for each image, the act of swiping often takes longer than simply tapping a screen. There also could have been an effect of the amount of time that was taken to swipe overall that might have caused people automatically to spend more time viewing the image, which could have played a role in how the participants were able to remember the different images. Especially when thinking about time, typically the more time someone spends either studying, or interacting with something, the more likely they will be to remember it.

Another distinction that could have caused the significant differences in average accuracy scores, especially looking across experiments, was that in the first experiment, the participants were not told in the beginning that the images they saw in the first portion of the experiment would be used as a memory test in the second portion. The participants simply went into the experiment and could have thought that the experiment was more focused on the way that people respond when given different cues in a touch screen without taking the time to look thoroughly at the images to try to remember them. When it did come to the memory portion of the experiment, the participants also were not given any sort of sense of if they guessed correctly because there was no feedback beeps to tell them what they got right, and also could have encouraged them to not just click through the images to finish the experiment faster.

This could have been the case in the first experiment also because the participants in the first experiment were not given any sort of indication of whether they got the image correct or

not. Therefore, there was likely little incentive to try to guess accurately if they were not told if they got the answer right or wrong. This was changed in the second experiment, and the added feedback beeps could have created more of a game-like atmosphere for the participants to see how many answers they could have guessed correctly instead of having no idea what was right or wrong.

In the second experiment, there also could have been greater accuracy because of the way that participants were instructed to recall different images in each section by using the same movement. This idea of context-dependent memory has been tested in previous research that has discovered the context in which you learn something also is the best context for recalling the information. In the case of Godden & Baddeley (1975), the words that were learned underwater by a group of divers were also recalled more effectively underwater compared to on land. The same was the case for learning on land and recalling on land. To this previous research, the current study finding adds to the research that it might not just be where you learn the information, but how you learn the information that is also important in what you do to remember it later on. The greater accuracy could have also been due to including less images presented in each block of the second experiment compared to the first. This could have led to a reduced fatigue in the participants, and a greater accuracy in the recall portion of the experiment.

This experiment can also be connected to other previous research looking at the way that synthesizing information can likely cause better recall of the information. Especially in the context of learning in a classroom with laptops compared to freehand notes (Fried, 2007) the synthesizing of information was linked to higher retention of the information. This also relates to the current study because although Experiment 1 and 2 were set up differently, the main

difference was that the images that were swiped on did have to be interpreted in a way to figure out what way the object in the image was moving or where the movement might be moving if it was not immediately obvious. With the combination of using the same interaction as part of the recall and having an interpretation and synthesis of the information seen, this type of learning of information could add to how people can learn more effectively, especially in a technological setting.

As there is an increase in the use of touch screen applications in many different parts of the world and in different parts of an individual's life, these results could be interpreted in several ways. For one, the effect of the type of interaction on memory of random images could indicate that swiping is not only a more involved way of interacting with an image compared to tapping or simply viewing, but especially when the action is done in a way that makes sense with what is going on in the image it can cause a greater accuracy of memory, especially when the same action is done when the person is asked to remember it.

Limitations

In this experiment, there were several limitations that could be altered in future studies to possibly see different results. The first limitation is that the sample only included people only within the Connecticut College community. Because of this, the majority of the participants were within the same generation (Generation Z) that has grown up in a world where the internet has always existed for them. Therefore, they could be more likely to understand and be used to using a touch screen to swipe, tap or view in different settings, particularly if they have a smartphone or tablet.

Having the sample come primarily from the Connecticut College community that relies heavily on the use of laptops and desktop computers as well as the use of a cell phone or smartphone to participate in many class activities, it might be different from a sample from a community without that same type of access to similar technologies.

The other major limitation that was seen in the significant differences in response times was the that there was not a set limit on each of the interaction types, and therefore, watching the images for a longer period of time could have caused an effect simply because of the increased time spent on the image due to the type of interaction. This also could have been caused in some participants because the sensor used on the finger of the participant would occasionally take longer than others to register the action. There was an unclear indication as to why that was, but it could have caused the participant to view certain images longer than others.

Future Research

There are many ways that the results from this experiment could be continued in future research, specifically with the focus on advertising and even learning patterns that could be changing in different age groups. With a similar setup of experiment, one of the major aspects that could control the confounding variable of varying response times would be to make time a main factor in the interaction. This would help determine if it was the amount of time the participant spent on the interaction that possibly caused them to remember the images more, or if it was the act of swiping during the learning and the recall portion. Because the participants did on average spend a significant amount more time on swiping compared to any other condition, this would be a variable that could have affected how well the person learned the image.

To further research this topic, looking at brain activity could be a possible next step for the research in what parts of the brain are used when doing the action for the interaction during the learning portion compared to when they are doing the action when recalling the information. This could help see if all types of information are stored in the same place in the brain or if using the interaction, especially when there is more movement and interpretation of the image, causes more or less brain activity in areas related to the motor system.

Another way to further this research could be looking at the same types of interaction on longer-term memories. As many advertisements or types of information are seen once for a few moments and then again possibly at a later date, it would be interesting to look at how these different types of interaction cause differences in memory a day, a week or a month after first seeing the image compared to within the same 30 minute period.

This study used college students, and ones that likely had used a swipe, tap or view function in their life, so as an extension of the study, participants of all different types of age groups could be looked at specifically comparing an older generation and a much younger generation. Although this might also have confounding variables of mental capacity in general, it might be helpful to know how an older population might benefit or not benefit from the use of newer advertising or learning strategies compared to a younger generation that has only grown up with the availability of these new platforms.

Real World Applications

While doing research on previous studies relating to interaction and memory involving advertisements or learning in general, it was apparent that there is a lack of information on this topic. The topic of cyberpsychology, how psychological behavior is changing with the addition

of technology in the environment (Norman, 2017), has expanded and is still discovering new complications or findings with the increase of technology in the world as a whole. Although there are growing concerns about how teaching and learning might change due to the increased amount of screentime, there is still not a lot of information on how to use these new types of technology to get the most out of it, simply because studies have not been done.

The effect of tapping versus swiping and viewing on advertising can help lead to future studies that might want to explore this topic even further, especially after finding significant results when using the same interaction as part of the recall portion. In current advertisements, there have been an increased number of brands that have begun to add their own type of advertising into a game-like setting, possibly so people might not recognize that they are being targeted for a specific brand (Yang et. al., 2006).

The results from this study also can be applied to many different advertising strategies as more of them are going online on a social media platform instead of in print or on a billboard. One of the biggest parts of the study that could also be studied more in depth was the addition of a movement element in the image that would make sense to the movement that the participant was instructed to do. With online advertisements that can have that touch element, the results from this study could help lead to further research on the most effective ways of getting people to remember advertisements that they see if the advertisement instructs them to interact in a way with what it is showing instead of making people swipe simply to swipe.

There is also not a lot of information on the ways that learning on a touch screen is able to cause someone to remember or forget what they are studying or learning in a classroom. This study could help indicate that, although there is still a lot more research to be done, swiping or

interacting with the information could cause better retention, at least for a short period of time. This would really be the case when recalling the information with the same interaction as was originally learned.

Lastly, when looking at the results from the first experiment where the participants were told how to interact with each image without a real reason why, they were possibly more focused on the action than the image, and there is a possibility that this could also be true for different types of advertising. Many advertisements today contain some sort of "interactive element" whether it is on instagram or in a game, but when the words "click here" are shown, that might not be the most effective way of catching attention or causing people to remember the advertisement in the first place. What might be better is incorporating a type of interactive movement that makes sense for the advertisement without simply telling people what to do.

Conclusion

There is still a significant amount of research needed to expand on this topic, mainly because this is one of the first types of studies looking at the differences between types of touch-screen interactions on memory. This research indicated that with many college-aged students, swiping can cause better accuracy in memory compared to any other type of interaction. However, the simple act of swiping might not be the only factor in causing individuals to remember the image more. Rather, the combination of having an image with a movement that makes sense with the action of swiping (such as a light switch moving up and down or a car moving right to left), and using the same action of swiping on recall could make the likelihood of people remembering the image to be greater.

With the connection of the results in this study to many possible advertising and learning strategies, this research is one of the first steps in figuring out how to encourage people to remember certain pieces of information more effectively than others when there are such high levels of information flooding minds everyday.

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Appendix A

Advertisements on Memory

Principal Investigators (PIs): [Margaret Davey]
Study Title: [Advertising Preference]
Address: Bill Hall
Connecticut College
270 Mohegan Avenue
New London, CT 06320

We are asking you to choose whether or not to volunteer in the research described below. The text below provides key information that may help you to make this decision.

Why is this research being done and what is involved?

The purpose of this study is to see how people interact with images.

When deciding to take part in the study you are asked to follow a few instructions in the experiment such as listening to voice commands and then swiping or tapping the screen.

You are also being asked to consent to publication of the study results as long as the identity of all participants is protected (here the data are anonymous, that is, no identifying information is collected).

This experiment should take from 20-30 minutes. You will receive credit for the time it takes to do the experiment.

It is anticipated that approximately 30 people will be involved in this study.

Do I have to participate?

Participation in this research study is completely voluntary and you are free to withdraw from the research at any time by alerting the researcher.

There is no penalty for withdrawing from the study. Your decision to volunteer for this study will not affect your current or future relationship with Connecticut College.

What are the risks and benefits?

We do not anticipate any risks to participating in this research other than those encountered in everyday life. Further, this study has been approved by the Connecticut College IRB.

You will get credit for research participation that may be necessary to your class if you come to complete the experiment.

Data Security

This data is being collected anonymously and therefore no identifying information will be included in any report involving the data collected. In addition, we will keep the data as secure as possible. You may obtain the results of this study in by requesting a copy of the final paper when available from Margaret Davey mdavey@conncoll.edu**.**

Whom can I talk to if I have questions or concerns?

If you have any questions or concerns about this research, you may contact Margaret Davey mdavey@conncoll.edu, the principal investigator for this research. You may also contact Jeff

Moher jmoher@conncoll.edu, the supervisor of the study, or IRB chair Dr. Jason Nier janie@conncoll.edu.

Statement of Consent

If you have read the above information, consent to take part in the study, and are at least 18 years of age, please sign below to confirm your consent. This research is considered Exempt from further Connecticut College IRB review under Exemption 2 (that includes Survey research) of the Code of Federal Regulations (45 CFR 46.114(d)(2).

……

Electronic Signature: _____

Appendix B

Physical Interaction on Memory

Principal Investigators (PIs): [Margaret Davey]
Study Title: [Advertising Preference]
Address: Bill Hall
Connecticut College
270 Mohegan Avenue
New London, CT 06320

We are asking you to choose whether or not to volunteer in the research described below. The text below provides key information that may help you to make this decision.

Why is this research being done and what is involved?

The purpose of this study is to see how people interact with images.

When deciding to take part in the study you are asked to follow a few instructions in the experiment such as reading instructions and interacting with an image by swiping, tapping or using the keyboard to switch to the next image.

You are also being asked to consent to publication of the study results as long as the identity of all participants is protected (here the data are anonymous, that is, no identifying information is collected).

This experiment should take from 20-30 minutes. You will receive credit for the time it takes to do the experiment.

It is anticipated that approximately 30 people will be involved in this study.

Do I have to participate?

Participation in this research study is completely voluntary and you are free to withdraw from the research at any time by alerting the researcher.

There is no penalty for withdrawing from the study. Your decision to volunteer for this study will not affect your current or future relationship with Connecticut College.

What are the risks and benefits?

We do not anticipate any risks to participating in this research other than those encountered in everyday life. Further, this study has been approved by the Connecticut College IRB.

You will get credit for research participation that may be necessary to your class if you come to complete the experiment.

Data Security

This data is being collected anonymously and therefore no identifying information will be included in any report involving the data collected. In addition, we will keep the data as secure as possible. You may obtain the results of this study in by requesting a copy of the final paper when available from Margaret Davey mdavey@conncoll.edu**.**

Whom can I talk to if I have questions or concerns?

If you have any questions or concerns about this research, you may contact Margaret Davey mdavey@conncoll.edu, the principal investigator for this research. You may also contact Jeff

Moher jmoher@conncoll.edu, the supervisor of the study, or IRB chair Dr. Jason Nier janie@conncoll.edu.

Statement of Consent

If you have read the above information, consent to take part in the study, and are at least 18 years of age, please sign below to confirm your consent. This research is considered Exempt from further Connecticut College IRB review under Exemption 2 (that includes Survey research) of the Code of Federal Regulations (45 CFR 46.114(d)(2).

……

Electronic Signature: _____

Appendix C

Debriefing Statement

First of all, thank you for participating in this research looking at the different ways that interaction with an image can affect memory. Now that technology truly is part of most people's everyday lives, and vast amounts of information is seen everyday on smartphones, on computers, on television and more, grabbing attention is becoming harder to do. Standing out from all the other moving and colorful images is hard in itself, but getting people to actually remember what they see is also a challenge. Therefore, it is important to understand how to convey messages that are important for the everyday individual such as warning messages and advertisements. In fact, there is a fair amount of information on this topic already, however, a lot of the current literature does not offer insights into the impact that interacting with an image or word can have on how you remember what you see. Before examining the data from this experiment, I hypothesize that 1. Participants will remember more images that they swipe, rather than click. And I also hypothesize that 2. Participants will remember images better when they hear a command rather than when they read it.

We ask that you do not share this information with your peers until the end of the year when the study is completed.

Should you have any questions or concerns about the manner in which this study was conducted, please contact Margaret Davey mdavey@conncoll.edu. You may also contact the IRB Chairperson Dr. Jason Nier janie@conncoll.edu.

If you are interested in this topic and want to read the literature in this area, you might enjoy the following articles:

Cho, C., & University of Texas at Austin. (2004). Why do people avoid advertising on the internet? *Journal of Advertising, 33*(4), 89-97. doi:10.1080/00913367.2004.10639175

Ha, L., & McCann, K. (2008). An integrated model of advertising clutter in offline and online media. *International Journal of Advertising, 27*(4), 569-592. doi:10.2501/S0265048708080153

If you would like to read the informed consent document again, please follow this link: https://docs.google.com/document/d/1xG0BCEK278RTcA-qhTM4jYlIDoTkmG7pkPxCjBRjXd8/edit?usp=sharing

Appendix D

Debriefing Statement

First of all, thank you for participating in this research looking at the impact of interaction attention on memory. Now that technology truly is part of most people's everyday lives, and vast amounts of information is seen everyday on smartphones, on computers, on television and more, grabbing attention is becoming harder to do. Standing out from all the other moving and colorful images is hard in itself, but getting people to actually remember what they see is also a challenge. Therefore, it is important to understand how to convey messages that are important for the everyday individual such as warning messages and advertisements. In fact, there is a fair amount of information on this topic already, however, a lot of the current literature does not offer insights into the impact that interacting with an image or word can have on how you remember what you see. Before examining the data from this experiment, I hypothesize that 1. Participants will have to synthesize information about how an object moves in the swiping portion of the experiment, and therefore, they will take longer to respond than in any other condition. 2. Participants will remember the images that they swipe compared to those that they just view. 3. Participants will recall images that they originally swiped on when they have to swipe to recall.

We ask that you do not share this information with your peers until the end of the semester when the study is completed.

Should you have any questions or concerns about the manner in which this study was conducted, please contact Margaret Davey mdavey@conncoll.edu. You may also contact the IRB Chairperson Dr. Jason Nier janie@conncoll.edu.

If you are interested in this topic and want to read the literature in this area, you might enjoy the following articles:

Cho, C., & University of Texas at Austin. (2004). Why do people avoid advertising on the internet? *Journal of Advertising, 33*(4), 89-97. doi:10.1080/00913367.2004.10639175

Ha, L., & McCann, K. (2008). An integrated model of advertising clutter in offline and online media. *International Journal of Advertising, 27*(4), 569-592. doi:10.2501/S0265048708080153

If you would like to read the informed consent document again, please follow this link: https://docs.google.com/document/d/1OMqGE_1cY69fgM6fsnLjwzsC5z8GyMHgy76h6hI98rE/edit?usp=sharing

Appendix E

Demographic form (Note: this will be made into a web form):

Age: _____

What is your gender?

a. Male
b. Female
c. Transgender Female
d. Transgender Male
e. Gender Variant/Non-Conforming
f. Other _____
g. Prefer not to answer

Ethnicity (select one):

a. Hispanic or Latino
b. Not Hispanic or Latino

Race: (select all that apply):

a. American Indian or Alaska Native
b. Asian
c. Black or African American
d. Native Hawaiian or Other Pacific Islander
e. White
f. Other _____

Handedness:

a. Right
b. Left
c. Other

Vision:

a. Normal
b. Corrected-to-normal

Colorblind

a. Yes
b. No