Generation and the Google Effect: Transactive Memory System Preference Across Age

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GENERATION AND THE GOOGLE EFFECT: TRANSACTIVE MEMORY

SYSTEM PREFERENCE ACROSS AGE

by

JESSICA SILER

A thesis submitted in partial fulfillment of the requirements for the Honors in the Major Program in Psychology in the College of Sciences and in the Burnett Honors College at the University of Central Florida Orlando, Florida

Summer Term 2013

Thesis Chair: Dr. Peter A. Hancock
ABSTRACT

A transactive memory system (TMS) is a means by which people may store information externally; in such a system the task of remembering is offloaded by remembering where information is located, rather than remembering the information itself. As Sparrow et al. (2011) suggest in the article *Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips*, people are beginning to use the internet and computers as a TMS, and this use is changing the way people encounter and treat information. The purpose of this thesis is to investigate whether preference for TMS type (either with books or with computers) varies across age groups. An interaction between TMS preference and age was hypothesized. Before the onset of the internet age, information was primarily found in books and other print materials whereas now the internet is more frequently used, thus this shift in thinking and habit across generations was expected to emerge in the data. The study yielded a total of 51 participants, 32 from the young age group (ages 18-24) and 19 from the old (ages 61-81). A modified Stroop task and question blocks (for priming purposes) were employed to examine whether people are prone to think of book- or computer-related sources when in search of information. Also, a “Look up or Learn” tendencies survey was used to better understand how people decide whether certain information should be learned or left to be “looked up” later (Yacci & Rosanski, 2012). The mixed ANOVA did not reveal main effects for question difficulty or TMS type, nor was an interaction with age found. The results were not consistent with those of Sparrow et al. (2011) and did not show significance for TMS preference. Future studies should continue to examine the Google effect and TMS preference, as it bears important applications for a number of fields.
ACKNOWLEDGMENTS

I would first like to thank my wonderful committee – Dr. Peter A. Hancock, Dr. Valerie Sims, and Dr. Michele Gill – for their support and guidance through this endeavor. I would also like to thank the Honors in the Major program for this opportunity and all those amazing people at the Burnett Honors College. I’d like to thank Ben Sawyer for being the Gandalf to my Frodo through this adventure – thank you for putting up with my questions and my silliness. To my partners in science and shenanigans at the MIT lab at UCF, thank you – especially Petal LaBorde, Elisabeth Niederman, Stephen Perkins, and Daniel Hinton. Thanks to my sisters, Erika and Krystal, for being made of awesome. And thanks to my parents for bringing me into this world, I literally could not have done this without you.
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INTRODUCTION

We live in the age of information technology; through the Internet and related devices, such as smart phones, tablets, and laptops, we have been granted quick and reliable access to vast stores of information. According to the International Telecommunication Union, the percentage of people online in the developed world reached 70% by the end of 2011, and Internet bandwidth has increased seven-fold from 2006 to 2011 (2012). As a result, many questions and concerns have surfaced, specifically regarding how this new way of accessing information may change human thought. Adoption of new intellectual technologies will result in offloading of an element of human cognition, memory, to the Internet. The fear is that offloading our memory will lead to the loss of what makes us human – our thought and intelligence. There are also those that feel this “cognitive hybridization” is normal, that we are “natural-born cyborgs,” and that this tendency to employ new tools and media to complement cognitive processes will continue (Clark, 2001).

Historically, new information media are not always welcome, and have frequently been debated. As far back as the 4th century, Socrates voiced his objection to written language, ironically through Plato’s work Phaedrus. Socrates strongly believed writing would threaten oral tradition, memory, and wisdom leading to forgetfulness and superficial understanding (Carr, 2011). He thought the written word would hold man back, and seriously hinder intellectual growth (Wolf, 2008). In the 15th century, when Johannes Gutenberg introduced his printing press, many feared the new availability of the printed word would lead to “intellectual laziness” and would undermine true scholarship (Carr, 2008). Today, with the advent of the personal computer and the growing
availability of the Internet, these concerns have resurfaced. The pattern holds, whenever a new intellectual technology is introduced it is swiftly met with resistance.

Sparrow et al. (2011), in a series of four experiments, concluded that when people believe they will have future access to information, recall of that information declines, yet recall for where that information may be accessed increases. This emerging tendency to remember where information may be retrieved rather than remembering the information itself has been termed the ‘Google effect’ of memory (Sparrow et al., 2011). This theory may indicate a change in the way people think and learn, specifically in how human memory is adapting and changing in response to new information media. Yet, this tendency is not entirely new. There has always been an affinity for developing transactive memory systems (TMS).

A transactive memory system is a means by which people may store information externally to be retrieved at a later time. This system allows people to recall where information is located, rather than commit to memory all the information itself (Peltokorpi, 2008). This memory technique was first observed in small groups of people and in dyads, such as married couples (Wegner, 1985). For example, in a TMS between spouses, the wife could be responsible for remembering family appointments and other dates, with the husband remembering important contact information, and then at any time each could consult the other for needed information. Therefore, each spouse is not burdened with memorization of all the information, yet they each enjoy access to it (Wegner, 1985). Within groups of people, each member becomes an “expert” in some area and they become responsible for any information pertaining to that area; hence, they become the source of information from that specific area to the entire group (Peltokorpi, 2008). Establishment and maintenance of a TMS involves: (1) the formation of meta-memories so that
each member of the group is aware of where certain information may be found (i.e. knowing who
the “experts” are in the group), (2) adequate allocation of incoming information (i.e. ensuring each
piece of new information finds its way to the appropriate “expert”), and (3) retrieval coordination
(i.e. knowing where to go to for desired information) (Wegner, 1995). In terms of the Google
effect, this could mean (1) forming meta-memories for where you could go for certain information
(ex: IMDb for movie-related information, Google Scholar for journal articles, etc.), (2)
organizing/storing that memory in an appropriate location (ex: bookmarking a website to your
favorites, saving files in a specific folder on your computer, etc.), and (3) retrieving the information
(ex: going to your bookmarks, going to a specific folder on your computer, etc.). In sum, a TMS
allows a person access to a wider array of knowledge by coordinating one’s memory with agents in
the environment, such as other people or the Internet.

As stated, this theory was recently furthered by Sparrow in studies on how people are
coming to form TMS with computers (2011). It has been suggested that because the Internet
provides such easy and available access to information, people may no longer be as likely to
encode new information (Sparrow et al., 2011). The first experiment of Sparrow’s study – on
which the current study is based – employed a modified Stroop task to determine if people were
inclined to think of computers when in search for knowledge. Subjects were presented with two
blocks of questions (easy and hard), after which they were given a six-digit number to memorize (to
create a cognitive load) then they completed a modified Stroop task (Sparrow et al., 2011). The
question blocks served as priming material – the goal of which was to create a need for
information, i.e. to get the participant to think, “Where would I go to find this information?” A
Stroop task is essentially a color-naming task, a subject is presented with a term printed in some
color and it is then their task to name the color in which the term is printed as quickly as possible (Stroop, 1935). For example, Fig. 1 would be read as: blue, red, yellow, green, purple.

Figure 1: Stroop words

Unlike the traditional Stroop task that uses color terms to test for interference in color-naming, Sparrow’s modification of the Stroop task used computer and non-computer terms in order to determine if subjects had computers in mind (2011). Previous research has shown that reaction times (RTs) will be slower in the Stroop when the term presented is of interest and accessible, i.e. when a person is thinking of the term (Segal, 1995). The data showed that when confronted with hard questions, when the need for information was high, subjects showed slowed RTs for computer terms in the Stroop as compared to the RTs for non-computer terms (Sparrow et al., 2011).

Though the Sparrow study purportedly shows this new tendency in memory to exist, clear evidence of that shift in thinking is missing from the current literature. A comparison of the so-called ‘Google effect’ across age groups would further research in this emerging area; and address these deficiencies by examining the preference for information mediums as they relate to age. The current study will investigate whether the preference for TMS types (with computers or with books)
varies with age. An interaction between system preference and age was hypothesized; this would provide evidence for the shift in thinking and habit that has occurred since the onset of the Internet and related media. Essentially this experiment is a recreation and extension of Experiment 1 from the Sparrow (2011) study; a modified Stroop task will be employed to explore the relationship between age and transactive memory system preference.

Since 2004, adoption of the Internet has steadily increased and a difference in penetration of the Internet across ages has become evident (Pew Research Center, 2012). It was not until the years 1995-2000 that the Internet came into common use; this period saw a rapid rise in Internet access around the world (International Telecommunication Union, 2012) and, more specifically, in public schools across the United States (National Center for Education Statistics, 2011). Based on this evidence, age groups in the proposed work will be broken into two main groups: young and old. These groups were divided in such a way as to ensure a stark difference in experience with information media. High levels of familiarity with new information media within the young age group are expected, as they have most likely used these media throughout their K-12 education. This group learned to seek information through computers, the Internet, search engines, smartphones, tablets, and so on from a relatively early age. Low levels of familiarity with new information media within the old age group are expected, as they did not enjoy the same access to these media throughout much of their lives. This group primarily learned to seek information by other means, such as libraries, books, and encyclopedias.
Hypotheses

- Main Effect of Age (young, old)
  - The mean RTs for the modified Stroop task will increase with age, because as people age their reactions naturally slow (Fozard et. al, 1994).

- Main Effect of System types (book-, computer-, neutral)
  - The mean RTs for the modified Stroop task will increase across system types, such that higher RTs will be observed for target words (computer- or book-related) than for neutral words because the neutral terms cause no interference.

- Main Effect of Question type (easy or hard)
  - The mean RTs for the modified Stroop task will be higher for hard questions than for easy because a stronger need for information is created.

- Interaction (Age X System type)
  - Those older in age will show a higher preference for books over computers; similarly, those younger in age will show a higher preference for computers over books. Therefore, those older will show higher RTs for books, and those younger will show higher RTs for computers.
METHOD

Participants

Fifty-one participants (34 females and 17 males) were randomly sampled from the University of Central Florida. The young group ranged from ages 18-24 (21 females and 11 males) and was recruited through SONA systems (a recruitment program that offers extra credit for certain classes); the old group ranged from ages 61-81 (13 females and 6 males) and was recruited through LIFE at UCF (an educational program for elders at UCF). Furthermore, they were tested in a within-subjects experiment, with two counterbalanced blocks between participants. This study was approved by the Institutional Review Board of the University of Central Florida (see Appendix E).

Design

This study will use a 3 X 2 X 2 X 2 ANOVA design: Stroop words (neutral, computer-, or book-related) X Age groups (young or old) X Question block types (easy or hard) X Gender (female or male). The RTs for neutral terms, as well as the RTs collected after the easy question block, will act as the controls within subjects. The dependent measures will include the RTs gathered from both Stroop tasks, as well as the responses from the “Look up or Learn” tendencies survey (see Appendix C).

Apparatus

The Stroop program was built using E-Prime 2.0 software. Within this program participants answered question blocks, completed Stroop tasks, and were presented with numbers to hold in short-term memory.
As participants began the program, they were first presented with a training exercise which allowed the participant to become familiar with the program’s design and method of entry (i.e. which buttons to press). This exercise involved a shortened Stroop task and was designed so that the participant could not advance until they made five correct responses, therefore ensuring each participant was competent in the use of the program.

Within the program, participants answered two question blocks, easy or hard (see Appendices A & B). Responses were submitted by pressing the ‘Q’ or ‘P’ keys on the keyboard, which were labeled with the answer choices ‘yes’ and ‘no.’ Participants were instructed to take their time during these sections. The purpose of these question blocks was to create different levels of need for information. The hard questions created a high need, and the easy questions a low need. Priming the participants in this manner should lead them to think of where they may go to find information.

After answering each question block, participants completed a modified Stroop task. In this task, the usual color words were replaced with words of interest, specifically computer- or book-related terms. A total of 32 terms were used and presented in random order and color for the Stroop task (see Table 1). These terms were selected based on their relevance to the target type (book- or computer-related). Many terms from the original study were used for replication purposes (Nelson, 2004; Sparrow et al., 2011). Brand names (such as “Google,” “Target,” “Yahoo,” and “Nike”) that were used in the original study were intentionally left out because of the possibility of color interference. These terms may have produced confounds in the data because they are already strongly associated with colors of their own.
Table 1: Stroop terms

<table>
<thead>
<tr>
<th>Neutral terms</th>
<th>Book-related</th>
<th>Computer-related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table</td>
<td>Hammer</td>
<td>Book</td>
</tr>
<tr>
<td>Piano</td>
<td>Laser</td>
<td>Text</td>
</tr>
<tr>
<td>Shell</td>
<td>Feather</td>
<td>Library</td>
</tr>
<tr>
<td>Quilt</td>
<td>Pants</td>
<td>Literature</td>
</tr>
<tr>
<td>Bicycle</td>
<td>Week</td>
<td>Page</td>
</tr>
<tr>
<td>Scissors</td>
<td>Rain</td>
<td>Read</td>
</tr>
<tr>
<td>Mosquito</td>
<td>Trumpet</td>
<td>Encyclopedia</td>
</tr>
<tr>
<td>Hairspray</td>
<td>Cinema</td>
<td>Publication</td>
</tr>
</tbody>
</table>

Furthermore, the design of the Stroop program closely modeled that of the Implicit Association Test (IAT) (Greenwald, Nosek, & Banaji, 2003). Participants were informed that they would be completing a timed task and were instructed to categorize each term as quickly as possible. Participants were presented with the terms in random order in either blue or red, and their task was to categorize them by pressing the ‘E’ or ‘I’ keys on the keyboard, which were labeled with red and blue colored stickers. Also, any incorrect selections resulted in the appearance of an “X”. Below are sample screens as they appeared in the computer program (not necessarily in that order).
As in Sparrow et al. (2011) a cognitive load task was utilized to avoid ceiling effects; participants were instructed to hold a six-digit number in memory during each of the Stroop tasks. The number was presented just before each Stroop task and it was recalled just after.
After completing the entire Stroop program, participants answered a “Look up or Learn” tendencies survey (Appendix C) and a demographics questionnaire (Appendix D). The “Look up or Learn” survey is designed to understand how people consume information, and how they decide whether to look up information later (i.e., on the internet or in a book) or to learn it (i.e., memorize). The demographics questionnaire simply requested more information about the participants themselves, such as their age, level of education, and experience with/use of different forms of information media (Purcell et al., 2012).

Procedure

Experimental sessions were conducted either individually or in small groups of two or three, and each session was scheduled in thirty-minute blocks. The experimental procedure is as follows:

1. The participant was greeted and given a consent form to read over (see Appendix F).
2. The participant was seated in front of the computer and the nature of the experiment was briefly explained. “You will be taking part in a Stroop, or color-naming, task – this task is designed to have you categorize items by their color as quickly as you can and your reaction times will be recorded. You will also be presented with a few question blocks. Follow the directions on the screen and ask a research assistant if you have any questions.”
3. The participant was then allowed to complete the Stroop program. The order of events is as follows:
   a. Training exercise
   b. Question block
   c. Number to memorize
d. Stroop task  
e. Recall the number  
f. Question block  
g. Number to memorize  
h. Stroop task  
i. Recall the number  

4. The participant was then allowed to complete the “Look up or Learn” survey, which was followed up by a demographics questionnaire (both presented through Qualtrics). For the “Look up or Learn” survey, participants were instructed, “For the purposes of this survey: 'Look up' means making a conscious decision to want or need to seek more information about a topic later; to remember where you may find information later, but not to memorize it now. For example: you decide not to memorize math formulas because you will be given a formula sheet during the test. “Learn” means being able to reproduce the information from memory.”
RESULTS

Modified Stroop Task

Reaction time (RT) data was collected and analyzed for all participants. 32 participants from the young age group, ranging from 18-24 (11 males, 21 females), were recruited from UCF through SONA systems. 19 participants from the older age group, ranging from 61-81 (6 males, 13 females), were recruited through the LIFE at UCF program. Means and standard deviations of RTs were calculated for each individual participant and any outliers within their data set were eliminated. Outliers were flagged as those RTs that were greater than three standard deviations from their mean. These values were flagged and eliminated because they were believed to create unnecessary influence on the data set – for example, those extremely high RTs may have been a result of a distraction within the experimental environment, rather than a result of the stimulus itself. Averages of those remaining RTs were then found for neutral terms, book-related terms, and computer-related terms across both conditions – the ‘easy’ Stroop, and the ‘hard’ Stroop. These values are reported in Appendix G. All data was run through IBM SPSS Statistics 19 software. It should also be noted that in terms of the question blocks themselves, the subjects generally found the easy questions answerable (90% were answered correctly) and found the hard questions rather difficult (51% answered correctly).

ROUND 1: A mixed between-within ANOVA was conducted to assess the impact of age groups (old or young) and gender (female or male) on RTs in a modified Stroop task, across target word type (neutral, book-related, or computer-related) and across question block difficulty (easy or hard). Average RTs for females are reported in Table 2 and males in Table 3. The ANOVA revealed a three-way interaction between difficulty, target, and gender as statistically significant F (2,
Another three-way interaction, between target, age, and gender, was found to be nearly significant $F(2, 46) = 3.184, p = 0.051$ (see Figures 5 and 6). A main effect for target was found to be statistically significant $F(2, 46) = 4.352, p = 0.019$. Also significant was a main effect for age $F(1, 47) = 101.442, p < 0.001$.

Table 2: Average RTs for Females

<table>
<thead>
<tr>
<th></th>
<th>Stroop Terms</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neutral/Unrelated</td>
<td>Book-related</td>
<td>Computer-related</td>
<td></td>
</tr>
<tr>
<td>Easy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Young</td>
<td>438.536</td>
<td>440.119</td>
<td>417.984</td>
</tr>
<tr>
<td></td>
<td>Old</td>
<td>649.411</td>
<td>678.015</td>
<td>667.048</td>
</tr>
<tr>
<td>Hard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Young</td>
<td>428.442</td>
<td>409.777</td>
<td>447.759</td>
</tr>
<tr>
<td></td>
<td>Old</td>
<td>663.243</td>
<td>629.298</td>
<td>679.425</td>
</tr>
</tbody>
</table>
Table 3: Average RTs for Males

<table>
<thead>
<tr>
<th>Age</th>
<th>Easy Stroop Terms</th>
<th>Hard Stroop Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neutral/Unrelated</td>
<td>Book-related</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td>450.505</td>
<td>445.354</td>
</tr>
<tr>
<td>Old</td>
<td>774.544</td>
<td>634.792</td>
</tr>
</tbody>
</table>
Figure 3: Target by Difficulty – Females
Figure 4: Target by Difficulty - Males
Figure 5: Target by Age - Females
ROUND 2: For further analysis, the data was recoded for certain words of interest. A look at the original study shows that the authors performed the ANOVA on specific words instead of the entire target word groups (i.e. all the computer-related words or all the book-related words) (Sparrow et al., 2011). Therefore, the current data was recoded such that average RT for book-related terms only considered RTs for book and library, similarly average RT for computer-related terms only considered computer and internet. These new values are reported in Appendix H. Once again, a mixed between-within ANOVA was conducted to assess the impact of age groups.
and gender on RTs in a modified Stroop task across target word type and question block difficulty. Average RTs are reported in Table 4 for females, in Table 5 for males. The ANOVA revealed a significant main effect for difficulty $F(1, 47) = 6.354, p = 0.015$. Also significant was a main effect for age $F(1, 47) = 97.885, p < 0.001$.

Table 4: Average RTs (words of interest) - Females

<table>
<thead>
<tr>
<th></th>
<th>Stroop Terms</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Neutral/Unrelated</td>
<td>Book-related</td>
<td>Computer-related</td>
</tr>
<tr>
<td>Easy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Young</td>
<td>438.536</td>
<td>458.452</td>
<td>396.786</td>
</tr>
<tr>
<td></td>
<td>Old</td>
<td>649.411</td>
<td>680.077</td>
<td>615.346</td>
</tr>
<tr>
<td>Hard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Young</td>
<td>428.442</td>
<td>408.262</td>
<td>418.929</td>
</tr>
<tr>
<td></td>
<td>Old</td>
<td>663.243</td>
<td>600.077</td>
<td>627.154</td>
</tr>
</tbody>
</table>
ROUND 3: To better understand the interactions found in Round 1 of data analysis, data from Appendix G was rerun through SPSS with the file split by gender. Average RTs for each gender can be found in Tables 2 and 3. A mixed between-within ANOVA was conducted to assess the impact of age groups and gender on RTs in a modified Stroop task, across target word type and question block difficulty. For the females, a significant interaction was found between difficulty and target F (2, 31) = 4.894, p = 0.014 (see Figure 3). Also significant for the females was a main effect for age F (1, 32) = 94.336, p < 0.001. For the males, a near significant main effect was found for difficulty F (1, 15) = 3.514, p = 0.058. Also significant for the males was a main effect for age F (1, 15) = 27.045, p < 0.001.

ROUND 4: Similarly, the data was rerun through SPSS with a file split by gender. This time, data from Appendix H, which uses RTs for those words of interest, was used. Average RTs for each
gender can be found in Tables 4 and 5. A mixed between-within ANOVA was conducted to assess the impact of age groups and gender on RTs in a modified Stroop task, across target word type and question block difficulty. For the females, a significant interaction was found between difficulty and target F (2, 31) = 3.303, p < 0.05 (see Figure 7). Also significant for the females was a main effect for age F (1, 32) = 88.427, p < 0.001. For the males, a significant main effect was found for difficulty F (1, 15) = 5.493, p = 0.033. A near significant main effect was found for target F (2, 14) = 3.517, p = 0.058. Also significant for the males was a main effect for age F (1, 15) = 26.796, p < 0.001.

Figure 7: Target by Difficulty – Females (words of interest)
“Look up or Learn” Survey

All participants also completed a “Look up or Learn” survey (see Appendix C) which asked them to judge on a Likert-type scale whether they were more likely to ‘look up’ or ‘learn’ information in a series of situations (Yacci & Rosanski 2012). Responses included the categories: Always Learn, Sometimes Learn, No Priority, Sometimes Look up, and Always Look up. Question topics are summarized in the table below (Yacci & Rosanski 2012). Means and medians for each age group are reported in Figures 8 and 9. Results of this survey for each age group are summarized in Figures 10 and 11.

Table 6: Look up Learn Question Topics

<table>
<thead>
<tr>
<th>Question #</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abstract concepts</td>
</tr>
<tr>
<td>2</td>
<td>Details or facts</td>
</tr>
<tr>
<td>3</td>
<td>Material is easy</td>
</tr>
<tr>
<td>4</td>
<td>Interested in subject</td>
</tr>
<tr>
<td>5</td>
<td>Not interested in subject</td>
</tr>
<tr>
<td>6</td>
<td>Needed for exam or relevant</td>
</tr>
<tr>
<td>7</td>
<td>Topic is accessible</td>
</tr>
<tr>
<td>8</td>
<td>Much related information</td>
</tr>
<tr>
<td>9</td>
<td>Time to spend</td>
</tr>
<tr>
<td>10</td>
<td>Skill needed frequently</td>
</tr>
<tr>
<td>11</td>
<td>Content is mathematical</td>
</tr>
</tbody>
</table>
Figure 8: Means and Medians per Question – Young Age Group

Figure 9: Means and Medians per Question – Old Age Group
Figure 10: Distribution of Responses per Question – Young Age Group
Figure 11: Distribution of Responses per Question – Old Age Group
DISCUSSION

A significant interaction between difficulty and target within the female group was found. As the rather ‘fishy’-looking graph in Figure 7 depicts, females have much higher RTs for book-related words after the easy questions than after the hard. Across both easy and hard conditions, RTs for computer-related words remain lower than those for neutral words. Interestingly, in the hard condition, RTs for neutral words remain higher than both types of target words – this does not support the original hypothesis. Not only does the hard condition not cause higher RTs for those target words, but there is also no interaction with age. Although, a main effect for age did come out, as older people generally have slower RTs than younger (Fozard et. al, 1994). No main effects for target or difficulty were found. In general, none of the hypotheses were supported (other than that for age) and possible reasons for such are discussed in the limitations section below.

As the “Look up or Learn” data suggest, the older age group shows a stronger tendency for ‘looking up’ information as compared to the younger age group for ‘learning’. This finding may be due to population differences – the young age group is entirely made up of undergraduate students whose purpose it is to learn, therefore making them more inclined to answer as such.

The original study reported slower RTs for Google/Yahoo after hard questions as compared to Nike/Target $F(1, 66), p < 0.04$ (Sparrow et al., 2011). Sparrow et al. (2011) used those brand names as part of their word sets, which were intentionally avoided in the current study. Even though words of highest relevancy (book/library and computer/internet) were pulled out for comparison in Rounds 2 and 4 of data analysis, the results still did not reflect those of the original study. It was also reported that not knowing the answer to a hard question primes the need to search for it, which leads to thoughts of information sources (Sparrow et al., 2011). Generally, the
difficulty main effect was not found in the data, meaning that the easy and hard questions were not significantly different in producing thoughts of information sources. However, in Round 4 of data analysis a main effect for difficulty for the males did present itself. Upon further investigation of this effect, it was found that the easy RTs were higher than the hard – this finding still contradicts what was expected and what was found in the previous study.

**Limitations**

It should of course be noted that the samples used for this study were exceptional. Subjects in the old age group showed much greater variability in age than those in the young age group, and they were not representative of their population. These participants were gathered from the LIFE at UCF program, which indicates that they are very involved in learning and seeking out knowledge, they consume more information, and they are better versed in technology (ex: internet use) as compared to the general population of older people. Also, the sample sizes themselves may have been a problem because they were unequal – young with 32 and old with 19.

The question block priming may not have been an effective manipulation. Significantly higher RTs were expected after the hard question block, as compared to the easy, but the current findings do not support this hypothesis. This study was designed in such a way that the easy Stroop would have acted as a control condition, yet this is not reflected in the data. This is not due to the difficulty of the questions themselves; as reported, the easy questions were found to be quite answerable and the hard were much more challenging. It may be that the hard questions did not create the expected need for information and they did not initiate thoughts of information sources. A possible fix could be to ask more direct questions about information-seeking habits, ex: “where would you go to find this information?”
It also seems that the Stroop words themselves did not lead to their intended effect. Neutral terms were supposed to act as a control because the subject should not be thinking of those words. Theoretically, subjects should produce lower RTs for neutral terms. Similarly, the target (book- or computer-related) words, especially those that were pulled out in Rounds 2 and 4, should show higher RTs. As the current data suggests, there is no significant difference between the neutral words and the target which could mean either the priming was ineffective in getting the subjects to think of where they would go for information or the neutral words were too distracting.

**Implications**

The Google effect states that people are using their memory differently and that a trend is forming in which people are more likely to remember where information is stored rather than to remember the information itself. For the results to reflect this effect, they would have to show high TMS preference (for either books or computers), yet the current data is not consistent with this idea. Also, considering the “Look up or Learn” data collapsed over both age groups, there does appear to be a stronger tendency to ‘learn’ rather than ‘lookup;’ hence, this finding does not provide much support for the Google effect.

**Applications**

Research in Google effect and TMS preference has applications in many fields including, but not limited to, education, health, business and transportation. The Google effect means that we are changing the way we use our memory, we are not carrying as much information in our heads as before. We are now more inclined to offload memory to outside sources, such as the Internet. This trend could inspire a change in the way we teach and in the way we test. Students of this generation learn and use their memory differently than did their professors – therefore teaching
and testing styles may need to be adapted. For example, many resident physicians are reading less and relying more heavily on electronic resources to answer clinical questions (Edson et al, 2010). Naturally, depth of learning is also called into question. Knowing where knowledge may be acquired does not necessarily equate to mastery of that knowledge (Gorry, 2009). Furthermore, research in this area could also apply to the business world, in terms of how companies and their employees use information (Gorry, 2009), and also to the transportation world, in terms of how people have come to rely on GPS.
APPENDIX A: EASY QUESTION BLOCK
Easy Question Block

Answer choices: Yes or No

1. Are dinosaurs extinct?

2. Was Moby Dick written by Herman Melville?

3. Is the formula for water H.O?

4. Is a stop sign red in color?

5. Are there 24 hours in a day?

6. Is the current president of the United States Ronald Reagan?

7. Does 8 plus 8 equal 16?

8. Was John F. Kennedy assassinated in 1994?

9. Is oxygen a metal?

10. Are there 15 months in a year?

11. Is ketchup made with tomatoes?

12. Does 5 plus 7 equal 30?

13. Was Romeo and Juliet written by William Shakespeare?

14. Do all countries have at least two colors in their flags?

15. Was Cat in the Hat written by J.D. Salinger?

16. Does a triangle have 3 sides?
Hard Question Block

Answer choices: Yes or No

1. Does Denmark contain more square miles than Costa Rica?
2. Did Benjamin Franklin give piano lessons?
3. Does an Italian deck of cards contain jacks?
4. Did Alfred Hitchcock eat meat?
5. Are more babies conceived in February than in any other month?
6. Do all countries have at least two colors in their flags?
7. Was Czar Nicholas II executed in 1917?
8. Is Krypton’s atomic number 26?
9. Is the average age of a human eyelash 150 days?
10. Was Pompey defeated by Julius Caesar in 48 B.C.?
11. Were family names first used in Roman times?
12. Is myrmecophobia fear of ants?
13. Is Jones the most common name in America?
14. Do insects feel hunger?
15. Was Pepin king of the Franks from 482 to 511 A.D.?
16. Is a quince a fruit?
APPENDIX C: “LOOK UP OR LEARN” SURVEY
“Look up or Learn” Survey

Answer choices were presented as a Likert-type scale using ‘Always Learn’, ‘Sometimes Learn’, ‘No Priority’, ‘Sometimes Look up’, and ‘Always Look up’.

Explanation of terms given: 'Look up' means making a conscious decision to want or need to seek more information about a topic later; to remember where you may find information later, but not to memorize it now. For example: you decide not to memorize math formulas because you will be given a formula sheet during the test. “Learn” means being able to reproduce the information from memory.

1. When I encounter abstract concepts, I tend to:

2. When I will need details or facts about a subject, I tend to:

3. When I perceive the material to be easy, I tend to:

4. When I am interested in the subject or material under discussion, I tend to:

5. When I am uninterested in the subject or material under discussion, I tend to:

6. When I believe the material being discussed will be needed or is relevant to a project, or an exam topic, I tend to:

7. When the topic under discussion is accessible on the Internet, I tend to:

8. When there is lots of discussion and the topic has lots of information associated with it, I tend to:

9. If I have the time to spend on a topic, I will tend to:

10. If a skill is needed to frequently use the material, I will tend to:

11. If the content is very specific, such as mathematically related, I will tend to:
APPENDIX D: DEMOGRAPHICS QUESTIONNAIRE
Demographics Questionnaire

1. What is your age?
   - numerical entry

2. What is your sex?
   - Male
   - Female

3. Do you drive regularly? (at least once a week)
   - Yes
   - No

4. Do you work full- or part-time?
   - Full (30 hours or more per week)
   - Part (less than 3 hours per week)
   - Do not work

5. In which year did you graduate high school?
   - Numerical entry

6. What is the highest level of education you have completed?
   - High school diploma/GED
   - Associate’s degree
   - Bachelor’s degree
   - Master’s degree
   - Doctoral/Professional degree

7. Which type of degree are you currently pursuing?
   - High school diploma/GED
   - Associate’s degree
   - Bachelor’s degree
- Master’s degree
- Doctoral/Professional degree
- No pursuing a degree

8. Do you own a computer/laptop?
   - Yes
   - No

9. Do you own a library card?
   - Yes
   - No

10. Did you ever have dial-up Internet?
    - Yes
    - No

11. Are you familiar with the library’s card catalog system?
    - Not at all familiar
    - Slightly familiar
    - Somewhat familiar
    - Moderately familiar
    - Extremely familiar

12. Have you ever used encyclopedias for research?
    - Yes
    - No

13. How often do you access the internet on your phone?
    - All of the time
    - Most of the time
    - Some of the time
    - Rarely
Never
- I cannot access the internet on my phone

14. How often do you use your tablet/e-reader?
- All of the time
- Most of the time
- Some of the time
- Rarely
- Never
- Do not own a tablet or e-reader

15. How often do you go to the library to find information (ex: research for a paper)?
- Always
- Often
- Sometimes
- Rarely
- Never

16. How often do you read (books/newspapers/magazines/etc.)?
- Always
- Often
- Sometimes
- Rarely
- Never

17. How many books would you say you read in a year?
- Less than 5
- 5-10
- 10-15
- 15-20
18. How long have you been using the Internet?
   - Less than 1 year
   - 1-5 years
   - 6-10 years
   - 11-15 years
   - 15+ years

19. How frequently do you access the Internet?
   - Never use
   - Almost never
   - Sometimes
   - Almost every time
   - Frequently use

20. Approximately how many times a day do you access a computer/the Internet?
   - Less than 5
   - 5-10
   - 10-15
   - 15-20
   - 20+

21. How likely are you to look up information using a search engine (ex: Google or Yahoo) online?
   - Extremely unlikely
   - Unlikely
   - Neutral
   - Likely
   - Extremely likely

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22. How likely are you to look up in formation in a textbook or other nonfiction book?
   - Extremely unlikely
   - Unlikely
   - Neutral
   - Likely
   - Extremely likely

23. How much of the information you find in textbooks or other nonfiction books do you think is accurate and trustworthy?
   - All
   - Most
   - Some
   - Very little
   - None

24. How much of the information you find on the Internet (through search engines) do you think is accurate and trustworthy?
   - All
   - Most
   - Some
   - Very little
   - None

25. How confident do you feel in finding needed information when using a search engine online?
   - Not at all confident
   - Slightly confident
   - Somewhat confident
   - Moderately confident
   - Extremely confident
APPENDIX E: IRB APPROVAL LETTER
Approval of Human Research

From: UCF Institutional Review Board #1
FWA0000851, IRB00001138

To: Benjamin Sawyer and Co-PI, Jessica B. Siler

Date: March 14, 2013

Dear Researcher:

On 3/14/2013, the IRB approved the following human participant research until 3/13/2014 inclusive:

Type of Review: UCF Initial Review Submission Form
Project Title: Generation and the Google Effect: Transactive Memory System Preference Across Age
Investigator: Benjamin Sawyer
IRB Number: SBE-13-09211
Funding Agency: Grant Title: N/A
Research ID: N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form cannot be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu.

If continuing review approval is not granted before the expiration date of 3/13/2014, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in IRIS so that IIRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziugas, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/14/2013 11:09:10 AM EST

IRB Coordinator
APPENDIX F: INFORMED CONSENT
Generation and the Google Effect: Transactive Memory System Preference Across Age

Informed Consent

Principal Investigator: Ben Sawyer
Co-Investigator: Jessica Siler
Sub-Investigator(s): Elisabeth Neideman
Petra LaBorde
Daniel Hinton

Faculty Supervisor: Dr. Peter A. Hancock, D.Sc., Ph.D.
Investigational Site: University of Central Florida

You are being invited to take part in a research study which will include about 100 people. You must be 18 years of age or older.

What you should know about a research study:
- Someone will explain this research study to you.
- A research study is something you volunteer for.
- You should take part in this study only if you want to.
- You can agree to take part now and later change your mind.
- Your decision will not be held against you.
- You are free to ask any questions you want before you decide.

Purpose of the research study: The purpose of this study is to investigate whether preference for transactive memory systems (such as with computers or books) varies with age.

What you will be asked to do in the study: Participants will be directed to a computer program (e-prime) through which they will complete a series of short reaction-time tasks (modified Stroop tasks) and question blocks. From there, they will complete two questionnaires through Qualtrics.

Location: This study will require you to come to a lab in the UCF Psychology Building, Room 113 or Room 110 (computer lab). Depending on condition, some individuals may be run through the same protocol on laptops in other campus locations.

Time required: The requirements of this study can be completed in 60 minutes. The amount of time which you signed up for is the amount of time required for this study.
Risks: There are no reasonably foreseeable risks or discomforts involved in taking part in this study.

Benefits: There are no direct benefits received from taking part in this research.

Compensation or payment: There is no payment offered for this study; however extra credit may be assigned by SONA Systems. Once you complete the study, we will send verification to SONA Systems, who is in charge of assigning points to your account.

Confidentiality: Only people who have a need to review your personal data collected in this study will have access to this information. Your identity will be kept confidential. Your information will be assigned a code. All of the information from the study will be kept in a locked filing cabinet or stored on a password protected computer. Your information will be combined with information from other people who took part in this study. When the researcher writes about this study to share what was learned with other researchers, he will write about this combined information. Your name will not be used in any report.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints please contact MIT2 Lab Manager, Ben Sawyer, UCF Psychology Department by phone at 407-823-4344 or by email at sawyer@knights.ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.
APPENDIX G: RTS FOR EACH SUBJECT
Average RTs for Participants across Target Word Type and Question Block Difficulty

Age: 0 = young, 1 = old

Gender: 0 = female, 1 = male

<table>
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<th>Age</th>
<th>Gender</th>
<th>Easy Book</th>
<th>Easy Computer</th>
<th>Easy Neutral</th>
<th>Hard Book</th>
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APPENDIX H: RTS FOR EACH SUBJECT (WORDS OF INTEREST)
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Gender: 0 = female, 1 = male

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