GENERATION AND THE GOOGLE EFFECT: TRANSACTIVE MEMORY SYSTEM PREFERENCE ACROSS AGE

by

JESSICA SILER

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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.

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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, smart phones, 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 ages18-24 (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

Neutral terms		Book-related	Computer-related
Table	Hammer	Book	Computer
Piano	Laser	Text	Technology
Shell	Feather	Library	Keyboard
Quilt	Pants	Literature	Internet
Bicycle	Week	Page	Screen
Scissors	Rain	Read	Browser
Mosquito	Trumpet	Encyclopedia	Modem
Hairspray	Cinema	Publication	Monitor

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).

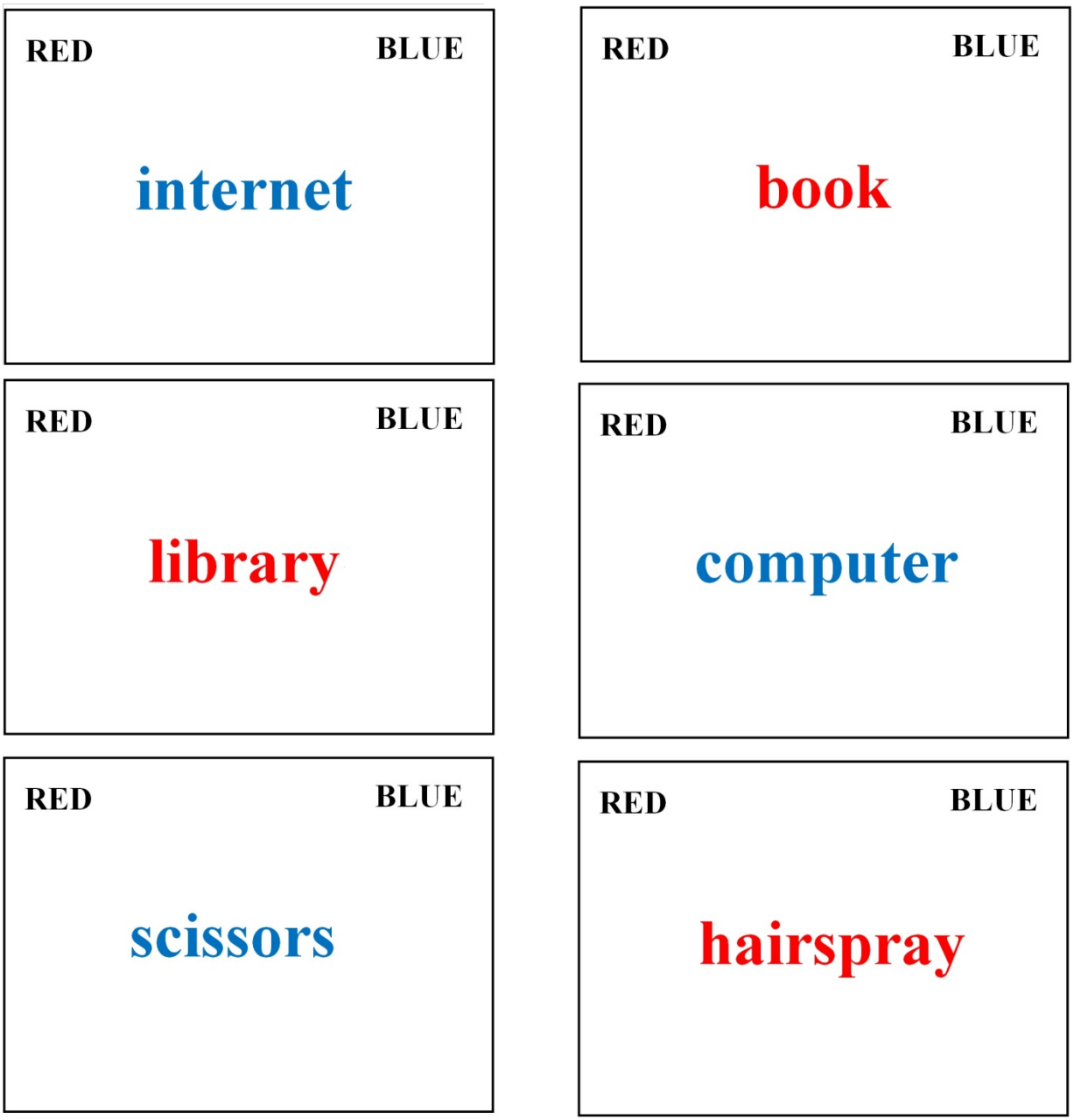

Figure 2: Sample Stroop screens

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,

46) = 4.360, $p = 0.018$ (see Figures 3 and 4). 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

Females					
Easy			**Stroop Terms**		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	438.536	440.119	417.984
		Old	649.411	678.015	667.048
Hard			**Stroop Terms**		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	428.442	409.777	447.759
		Old	663.243	629.298	679.425

Table 3: Average RTs for Males

Males					
Easy			**Stroop Terms**		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	450.505	445.354	444.979
		Old	774.544	634.792	701.011
Hard			**Stroop Terms**		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	419.180	421.154	427.386
		Old	645.200	631.188	681.568

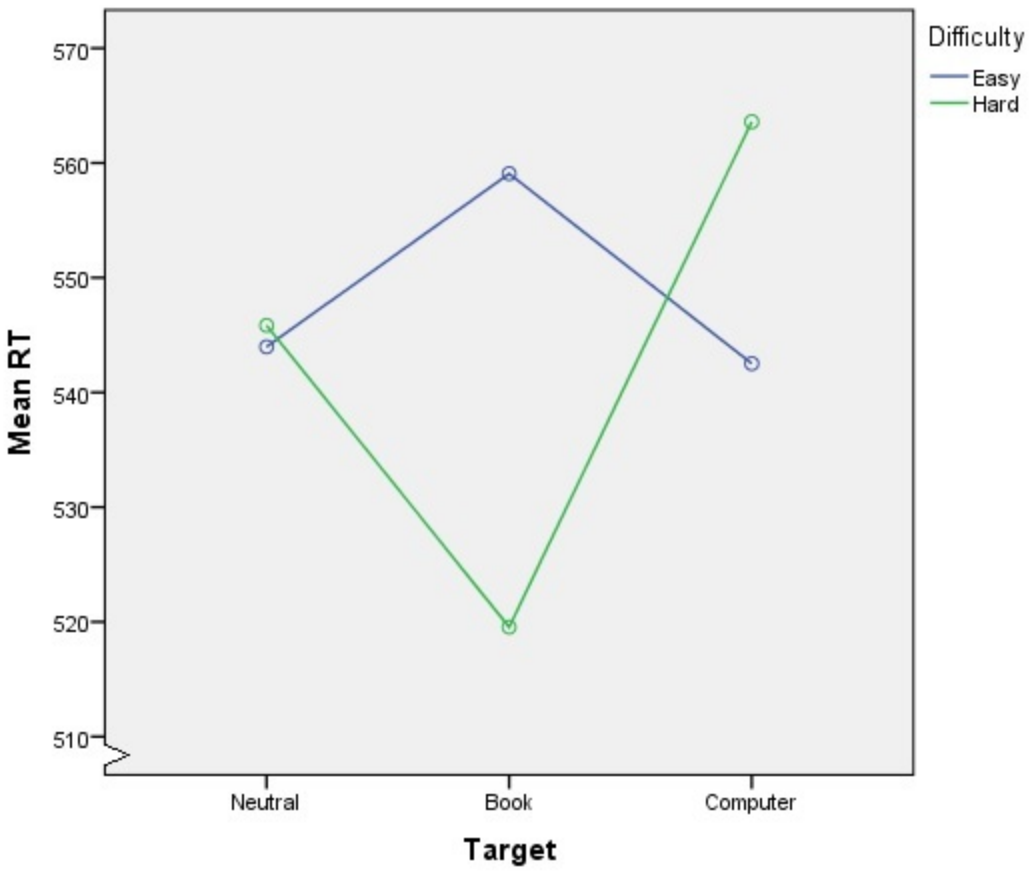

Figure 3: Target by Difficulty – Females

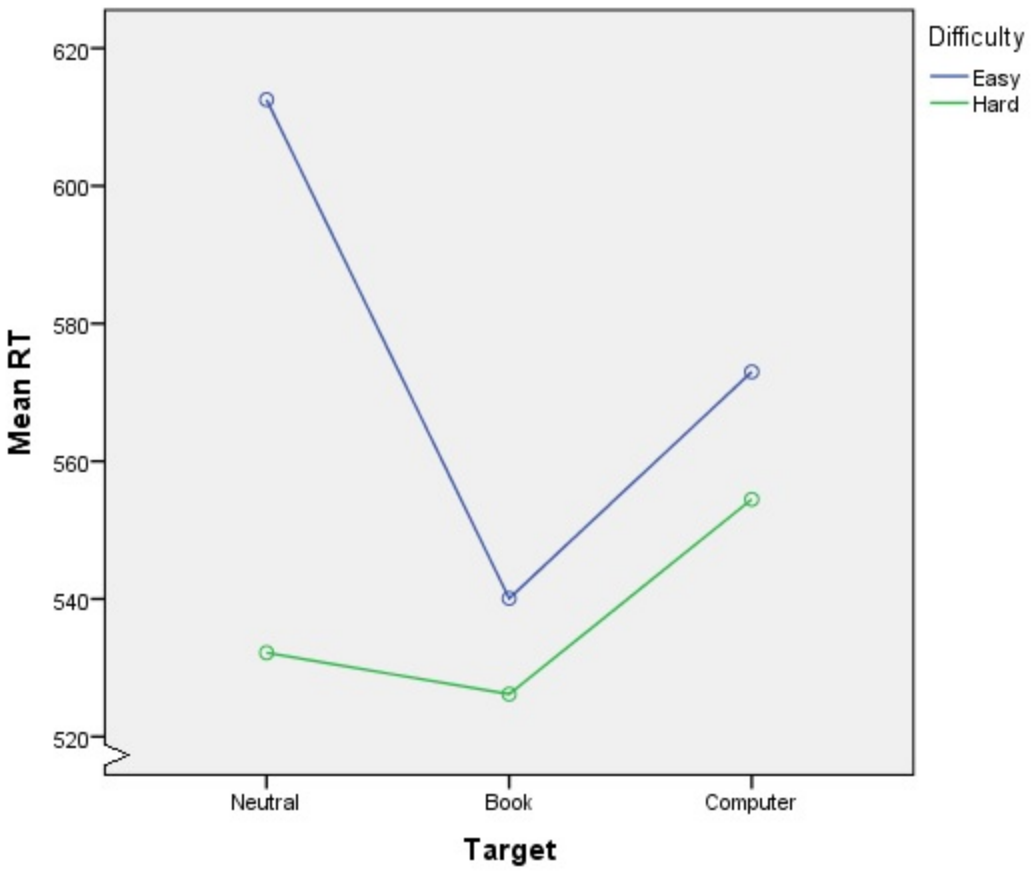

Figure 4: Target by Difficulty - Males

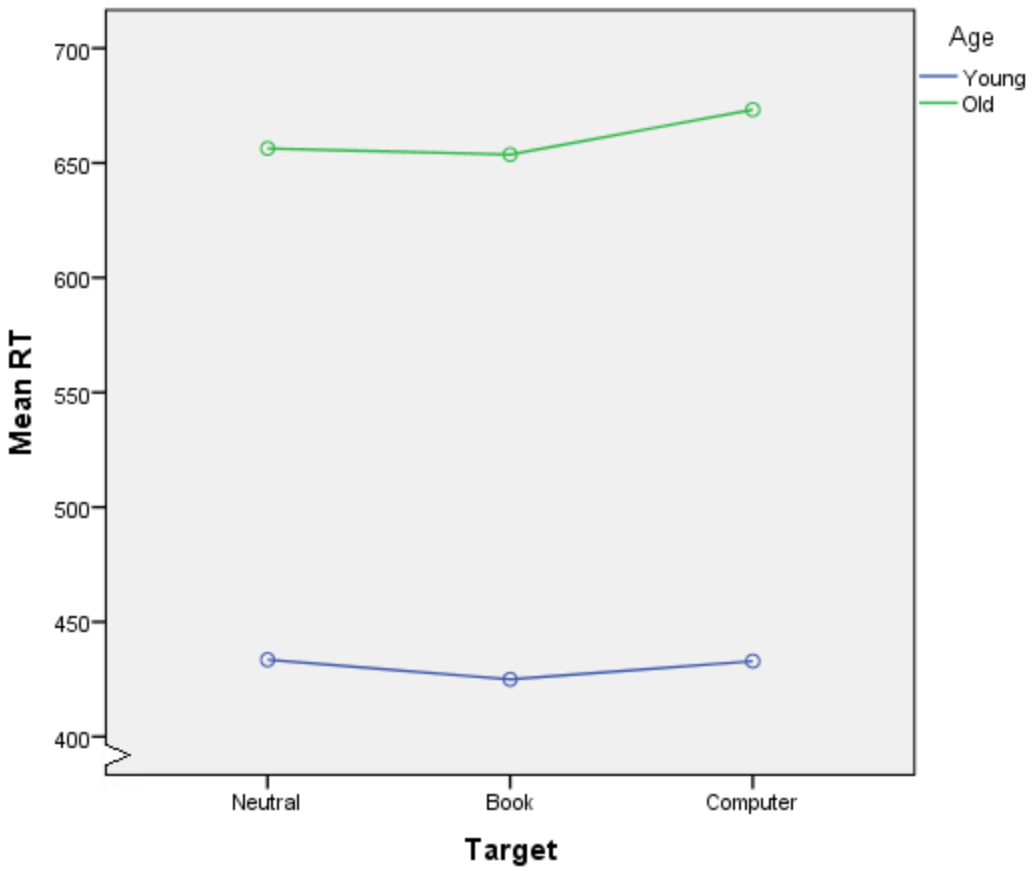

Figure 5: Target by Age - Females

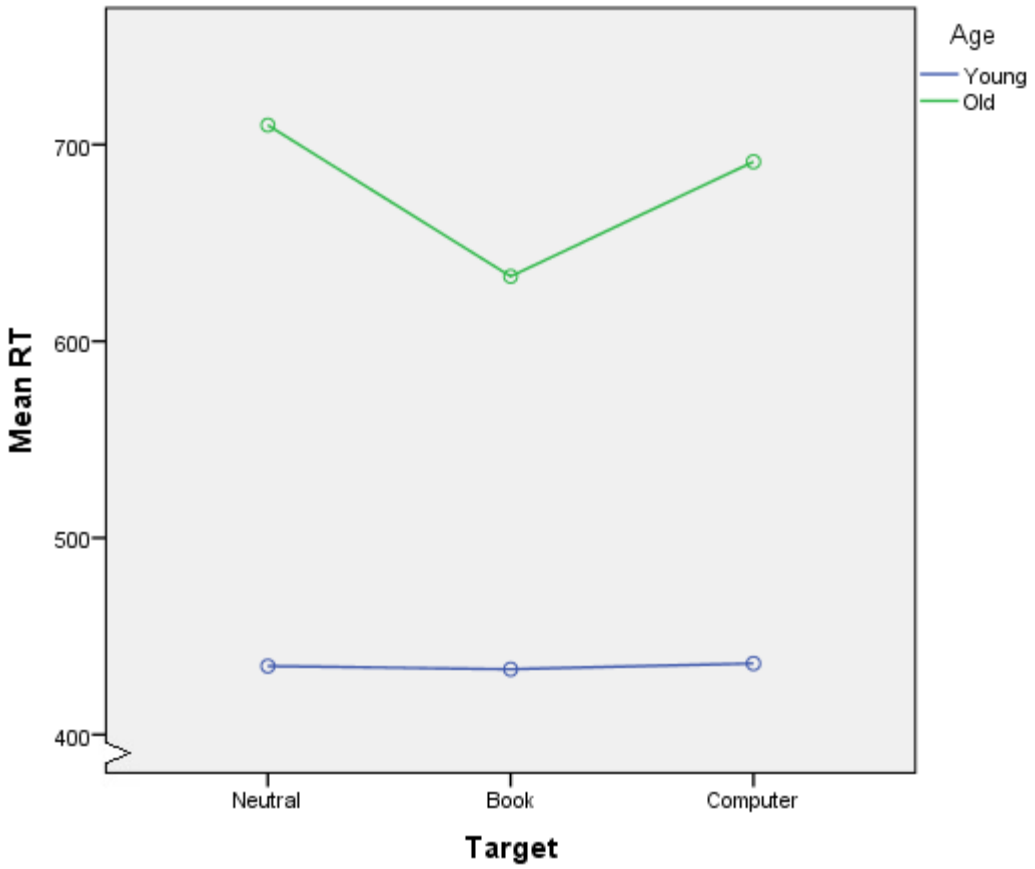

Figure 6: Target by Age – Males

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

Females					
Easy			Stroop Terms		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	438.536	458.452	396.786
		Old	649.411	680.077	615.346
Hard			Stroop Terms		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	428.442	408.262	418.929
		Old	663.243	600.077	627.154

Table 5: Average RTs (words of interest) - Males

Males					
Easy			**Stroop Terms**		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	450.505	431.273	472.773
		Old	774.544	691.417	713.833
Hard			**Stroop Terms**		
			Neutral/Unrelated	Book-related	Computer-related
	Age	Young	419.180	426.591	454.545
		Old	645.200	571.583	657.500

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 $F(1, 15) = 26.796$, $p < 0.001$.

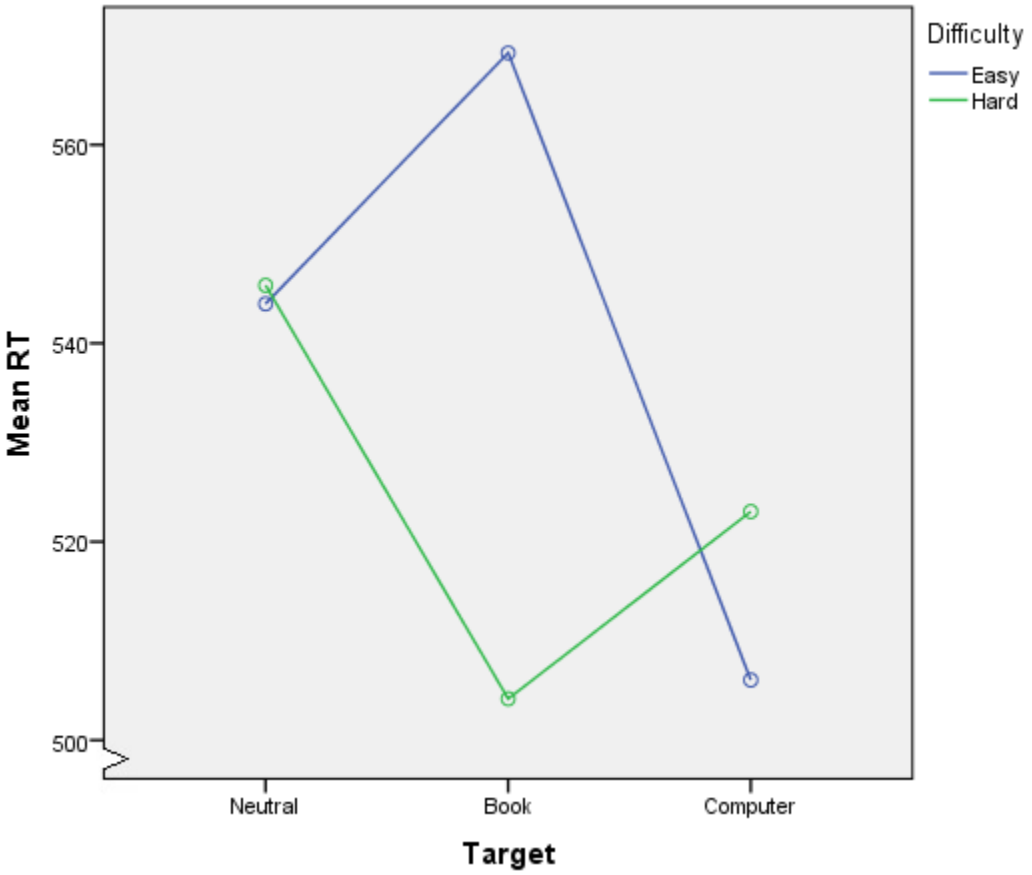

Figure 7: Target by Difficulty – Females (words of interest)

"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

Question #	Topic
1	Abstract concepts
2	Details or facts
3	Material is easy
4	Interested in subject
5	Not interested in subject
6	Needed for exam or relevant
7	Topic is accessible
8	Much related information
9	Time to spend
10	Skill needed frequently
11	Content is mathematical

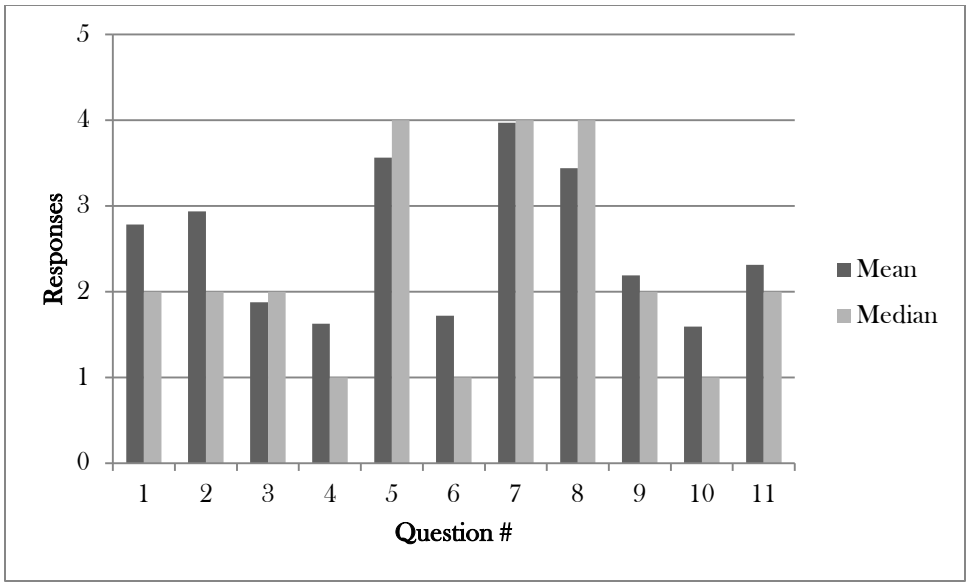

Figure 8: Means and Medians per Question – Young Age Group

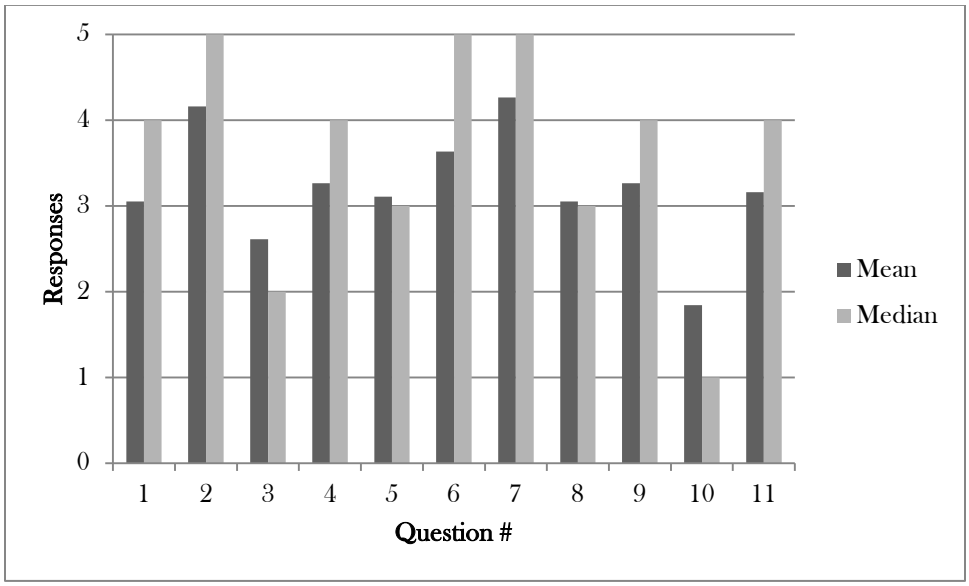

Figure 9: Means and Medians per Question – Old Age Group

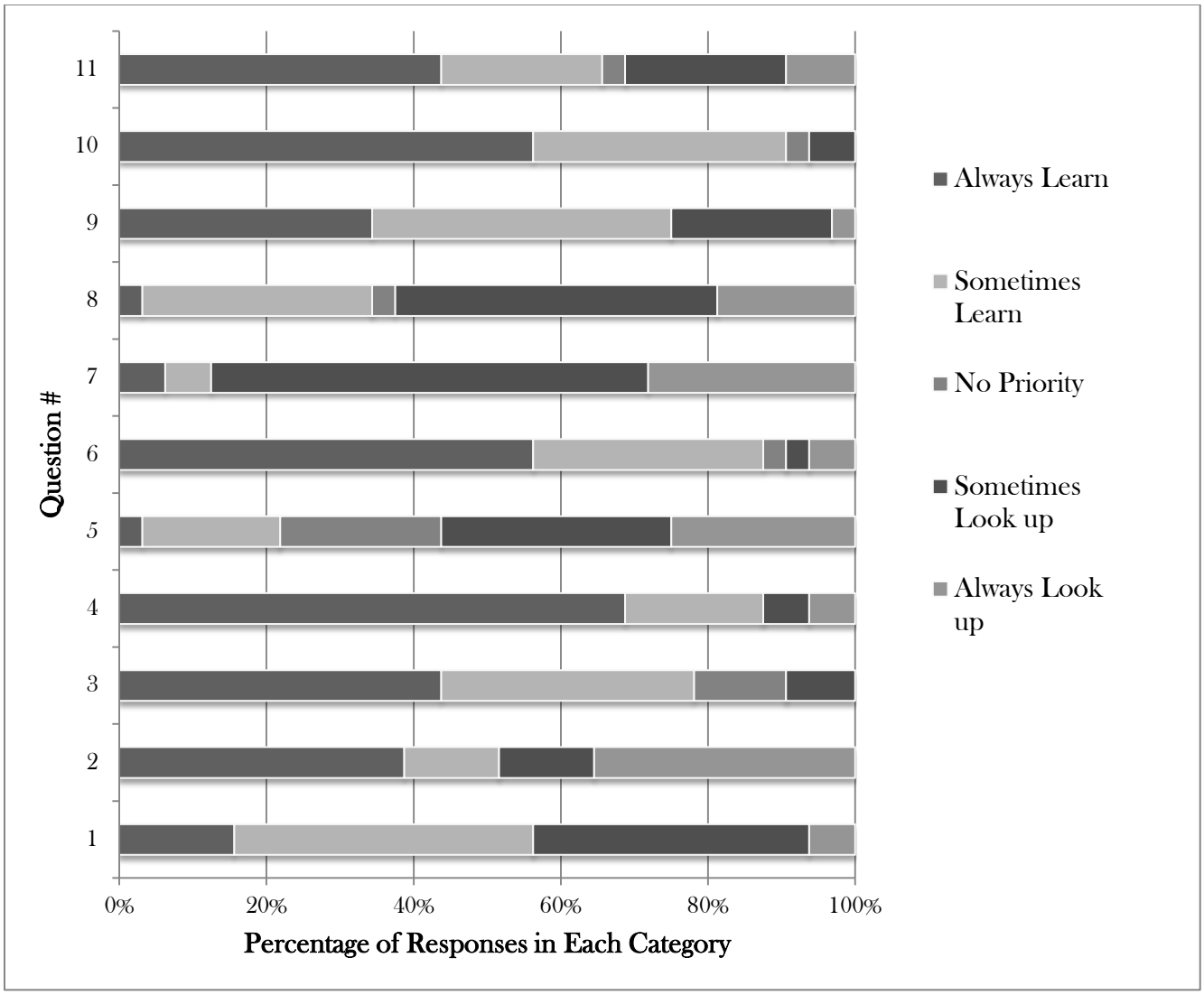

Figure 10: Distribution of Responses per Question – Young Age Group

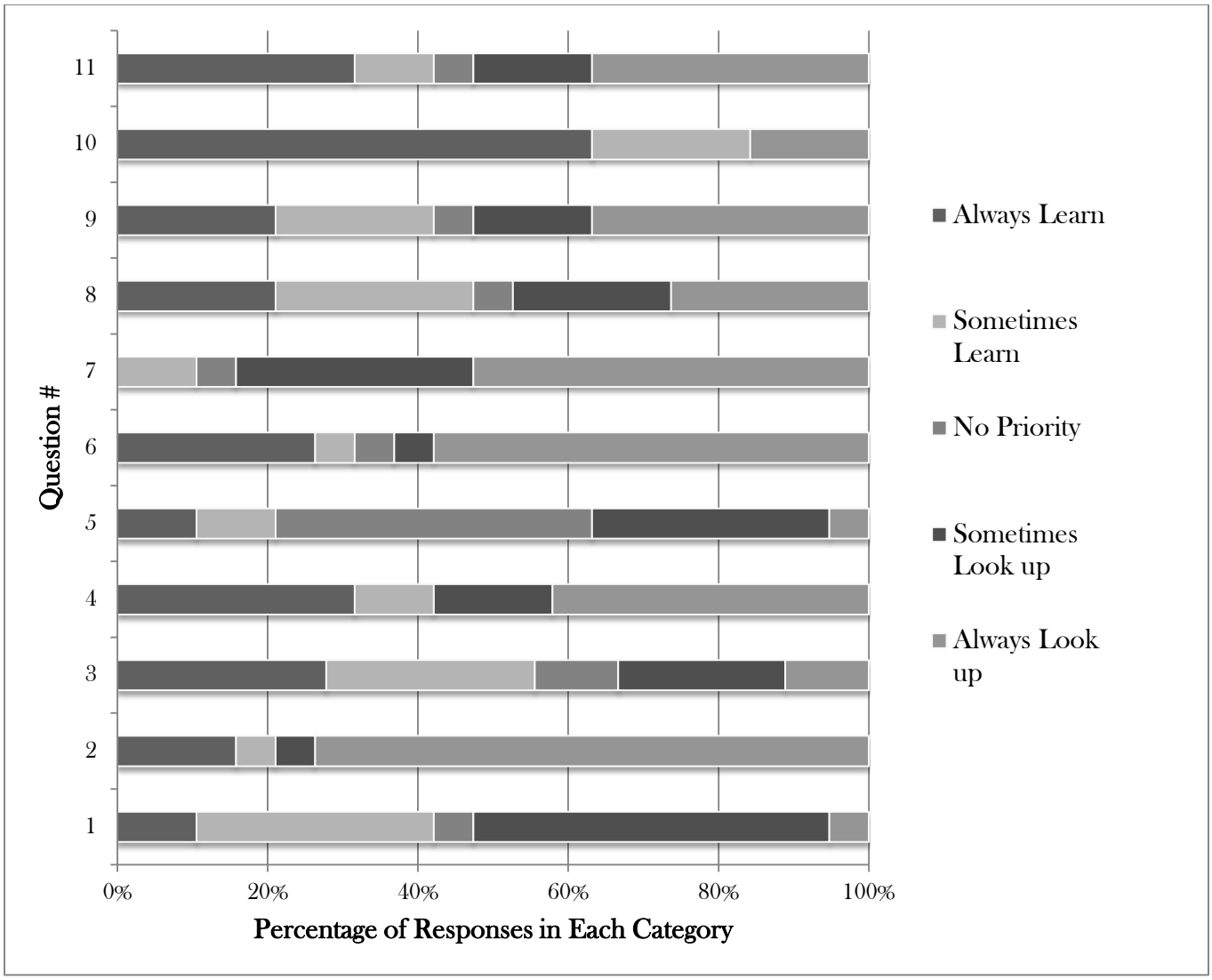

Figure 11: Distribution of Responses per Question – Old Age Group

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_2O?
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?

APPENDIX B: HARD QUESTION BLOCK

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

- 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

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

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, 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:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days 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 IRB 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 Dziegielewski, 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

Joanne Muratori

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 Neiderman

Petal 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 filling 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

Age	Gender	Easy Book	Easy Computer	Easy Neutral	Hard Book	Hard Computer	Hard Neutral
0	0	497.88	390.25	368.2666667	395.25	403.125	439.3125
0	0	633.625	357.375	520.6	443.875	504	542.125
0	1	312.125	290.5	316.9285714	298.875	323.375	314.0666667
0	0	418.125	379.25	444.4666667	465.375	395.75	396
0	1	425.25	361.875	395.8666667	392.125	419	371.625
0	0	651	632.875	494.4285714	449	435.25	414.3125
0	1	397.125	458.375	497.1333333	371.75	436	414
0	0	407.375	344.75	429.8666667	367.375	380.625	369.25
0	0	408	374.63	401.0666667	313.875	355.625	325.6875
0	0	523.125	534.375	538	482.57143	610.875	537.25
0	0	376.75	341.625	352.6	349.25	401.71429	351.375
0	0	477.75	524.25	496	459	494.625	504.125
0	1	376.375	425.625	374.6	391.25	506.875	375.25
0	0	415	417	429.8	474	473.5	491.8125
0	0	371.375	370.625	445.8125	397	457.75	377.1333333
0	0	383.875	383.75	372.3125	401.25	353	346.8
0	1	469.85714	449.5	440.4666667	427.125	506.625	464.6
0	0	345.25	357.5	408.3125	343	426.75	399.4666667
0	0	327.25	400.875	397	439.375	546.25	463.875
0	1	445.125	424.375	401.4375	462.125	39.5	406.9375
0	0	422.375	416.1429	425.8125	393.25	425.75	408
0	0	398.125	507.375	420.8125	479	601.625	642.375
0	0	358.375	309.875	360	301.5	374.375	354.75
0	0	437.75	404.125	508.3125	408.625	464.71429	377.875
0	1	443	410.125	406.5625	444.5	533	407.0625
0	0	512.125	434.125	466.5625	383.5	420.625	387.125
0	0	403.5	436.1429	447.2142857	442.25	486.875	442.9375
0	0	473.875	460.75	482	417	390.14286	425.6875
0	1	610.28571	520.5	619.1875	454.625	543.75	465.625
0	1	391.75	428.1429	428.0625	425.57143	396.875	404
0	1	427	432.125	512.8125	437.625	501.625	503.875

0	1	601	693.625	562.5	527.125	494.625	483.9375
1	0	631.125	557.875	593.625	647	557	645.125
1	1	476.875	478	536.0714286	460.125	544.625	442.5
1	0	642.13	765.38	584.6666667	416.25	424.5	467.6875
1	1	691.875	907.25	1217.642857	836.875	720.625	724.25
1	1	780.25	813.8571	757.6	623.25	637.125	653.8125
1	0	735.125	704.375	736.8125	750.125	804.71429	742.9375
1	0	625	617.125	593.125	649.625	629.875	696.6
1	1	656.125	655.125	697.0625	705.75	798.28571	928.9375
1	0	656.125	655.125	697.0625	705.75	798.28571	928.9375
1	1	689.5	782.55	689.2	630.5	677.5	593.2
1	0	657.5	537.875	573.9230769	562.875	1047.2857	644.5625
1	0	734	702.75	631.9285714	517.75	603.625	553.9375
1	0	544.57143	588.75	570.4375	578	536.75	523.8125
1	0	920.25	939.25	820.6	812.875	712.875	779.0625
1	0	612.5	666	699.5625	555.875	837.5	675.125
1	0	638.125	550.375	557.6	571.75	576.42857	601.75
1	0	701.75	699.625	635.125	618	554.83333	584.3125
1	1	514.125	569.2857	749.6875	530.625	711.25	528.5
1	0	716	687.125	747.875	795	748.85714	778.3125

APPENDIX H: RTS FOR EACH SUBJECT (WORDS OF INTEREST)

Average RTs for Participants across Target Word Type (for those words of interest) and Question Block Difficulty

Age: 0 = young, 1 = old

Gender: 0 = female, 1 = male

Age	Gender	Easy Book	Easy Computer	Easy Neutral	Hard Book	Hard Computer	Hard Neutral
0	0	720	287.5	368.2666667	328	288.5	439.3125
0	0	787.5	312	520.6	488	428.5	542.125
0	1	334.5	288	316.9285714	323	315	314.0666667
0	0	460	345	444.4666667	718.5	327	396
0	1	456.5	342	395.8666667	344	344	371.625
0	0	862.5	523.5	494.4285714	472	350	414.3125
0	1	347.5	482.5	497.1333333	459.5	414.5	414
0	0	310.5	355.5	429.8666667	359	350.5	369.25
0	0	413	388.5	401.0666667	265	322	325.6875
0	0	571	492.5	538	381	460.5	537.25
0	0	380	332.5	352.6	271	413	351.375
0	0	440	544.5	496	371.5	532.5	504.125
0	1	359.5	447	374.6	369.5	661	375.25
0	0	362.5	404	429.8	414.5	404.5	491.8125
0	0	347	299.5	445.8125	471	467.5	377.1333333
0	0	371	390	372.3125	357.5	314	346.8
0	1	444	411	440.4666667	506	448	464.6
0	0	310.5	378.5	408.3125	382.5	392.5	399.4666667
0	0	291.5	421.5	397	366	499.5	463.875
0	1	479	422.5	401.4375	399.5	364.5	406.9375
0	0	460	390	425.8125	361.5	418.5	408
0	0	424.5	649.5	420.8125	512.5	549.5	642.375
0	0	326.5	305.5	360	297	418	354.75
0	0	458	404	508.3125	409	638.5	377.875
0	1	610	352	406.5625	356	558	407.0625
0	0	466	316.5	466.5625	445	365.5	387.125
0	0	393.5	381	447.2142857	487	489	442.9375
0	0	472	411	482	416	368	425.6875

0	1	507	571	619.1875	354	540.5	465.625
0	1	371	507.5	428.0625	383	394.5	404
0	1	334.5	632	512.8125	460	445.5	503.875
0	1	500.5	745	562.5	738	514.5	483.9375
1	0	842.5	502	593.625	466	533	645.125
1	1	503	512.5	536.0714286	401	458	442.5
1	0	392.5	409	584.6666667	561.5	1016	467.6875
1	1	758	929	1217.642857	764.5	637.5	724.25
1	1	870	831.5	757.6	452	415.5	653.8125
1	0	866	896	736.8125	627	648.5	742.9375
1	0	536	664.5	593.125	485	715	696.6
1	1	717	534	697.0625	642.5	630.5	928.9375
1	0	717	534	697.0625	554	630.5	928.9375
1	1	783.5	740	689.2	438	897	593.2
1	0	473	501	573.9230769	847	702	644.5625
1	0	741	667	631.9285714	590	561.5	553.9375
1	0	525	555.5	570.4375	536	436.5	523.8125
1	0	679.5	647	699.5625	578	633	675.125
1	0	574.5	595.5	557.6	578	540.5	601.75
1	0	634	695.5	635.125	590.5	496	584.3125
1	0	781	677.5	747.875	579	743	778.3125
1	1	517	736	749.6875	731.5	906.5	528.5
1	0	1079	655	820.6	809	497.5	779.0625

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