AN ABSTRACT OF THE THESIS OF

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This study investigated evidence of the Stroop effect in Rapid Serial Visual Presentation (RSVP). Participants were 31 students enrolled in Introductory and Developmental Psychology classes at Emporia State University in the fall of 2000. Participants named the color (ink) that the second capitalized word was displayed in when viewing a series of RSVP streams on a computer. Each stream consisted of 20 items, 18 of those items were lower-case filler items, the other two words (Target 1 and Target 2) were the color names: Blue, Red, Green, and Yellow. Each word in the stream was displayed in one of four colors: Blue, Red, Green, or Yellow. If items appeared between the two target words, those items appeared in White. Significant main effects were found for the variables: Ink, T2, and Lag. A significant interaction effect was found for Ink and Lag. These results indicated that the ink that the target words were presented in (congruent vs. incongruent) made a difference in the proportion of correct responses. Whether T2 was congruent also made a difference in proportion of correct responses. The distance between T1 and T2 also made a difference in proportion of correct responses.

AN ANALYSIS OF THE STROOP EFFECT IN RAPID SERIAL VISUAL PRESENTATION

A Thesis

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CHAPTER 1

INTRODUCTION

Researchers typically view the Stroop effect as a perceptual phenomenon that serves to confuse and distract the reader by presenting incongruent stimuli. Over time, this phenomenon has become a tool for detecting mechanisms that are at work when we read. Since its conception in 1970 (Forster 1970), researchers have used Rapid Serial Visual Presentation (RSVP) in experimental procedures that deal with human sensation and perception. RSVP techniques facilitate our understanding of the mechanisms that are at work when we read. We have come to understand two of those mechanisms as the Attentional Blink and the Attentional Gate. The theory behind the Attentional Blink states that when stimuli are presented in rapid sequence, our sensory processing "shuts off," and we are unable to detect the next piece of information in the sequence. The Attentional Gate is very similar. When our sensory processing "shuts off," a certain amount of time must elapse before it "turns on" again. This process is like a swinging gate, hence the name.

Although a great deal of research exists on the Attentional Blink, the Attentional Gate, the Stroop effect, and RSVP, no experiment has ever incorporated all four components. In the present experiment, I focused on the interaction between the Stroop effect and RSVP streams of research. The Attentional Blink and Attentional Gate also played a role in the design of this experiment.

The Stroop effect

The Stroop effect occurs when word recognition interferes with color naming. For example, if words are presented in the following manner:

BLUE RED GREEN YELLOW PURPLE ORANGE

YELLOW GREEN ORANGE BLUE RED YELLOW

Word recognition would not interfere with the reader's ability to name the color of the ink because all the words are presented in black. However, according to the Stroop effect, if the words were presented in color in the following manner:

BLUE RED GREEN YELLOW PURPLE ORANGE

YELLOW GREEN ORANGE BLUE RED YELLOW

Word meaning would interfere with the reader's ability to correctly name the color of the ink. This phenomenon is called the Stroop effect.

According to Stroop (1935), when presenting two types of stimuli simultaneously (color naming and word meaning), the meaning of the word will interfere with the ability to name or identify color (ink). Stroop also suggests that the ability to identify the color will take more time than reading the word. Although researchers agree that some type of interference occurs when trying to identify color in a Stroop task, they disagree on the nature of the interference and its location in the information processing system.

Naish (1985) suggested that "Stroop interference occurs because word and colour information are processed at about the same time" (p. 304). Naish argued that interference occurs after the input of the stimulus and before the output of the

response. Thus, according to Naish, "there is a single locus for the interference, between the input and output stages" (p. 310). Hintzman et al. (1972) argued that the interference in a Stroop task occurs primarily at the output level rather than at the input stage. Hintzman et al. found that if interference occurred at the encoding stage, its interfering effects were minimal.

Schweickert (1983) suggested that interference occurs not at the processing level, but at the identification level. According to Schweickert, participants in a Stroop task identify the word before identifying the color to be reported. Identifying the word first leads to interference when trying to report the color. Liu (1973) suggested that identifying or reading the word when trying to name the color is involuntary. Liu presented participants with a Stroop task in which colored words were presented on cards and instructed the participants to hold the cards upside down. Holding the cards upside down decreased response time when naming the color. Liu argued that the interference in a Stroop task occurs as a result of involuntarily reading the word leads to longer response times when naming the color.

Cohen, Dunbar, and McClelland (1990) argued that speed of processing is the relevant feature of a Stroop task and suggested that participants process word meaning faster than they process color information. Processing word meaning before color information leads to interference when word meaning and color information conflict and the task is to name the color. Cohen et al. stated that participants are able to ignore the ink color of the word when trying to read the

word. However, when trying to name the color of the word, subjects have a difficult time ignoring the semantic interference of the word.

Moriguchi and Morikawa (1998) stated that when researchers instruct participants to read the word instead of identifying the color a reverse-Stroop effect (color interfering with word) occurs. Moriguchi and Morikawa state that the Stroop effect has been successfully demonstrated in the English, German, Japanese kana, and Japanese kanji languages. However, the reverse-Stroop effect is much more difficult to demonstrate, and its effects are not as profound. Durgin (2000) suggests that the reverse-Stroop effect is easier to demonstrate if the task is to match two stimuli by pointing to the response rather than vocalizing the response. Abramczyk, Jordan, and Hegel (1983) suggested that researchers can use the reverse-Stroop effect as an aid when diagnosing schizophrenia in clinical populations. Abramczyk et al. stated that persons diagnosed with schizophrenia display a more pronounced reverse-Stroop effect than normal individuals.

Although evidence of a reverse-Stroop effect exists, the standard Stroop effect (word meaning interfering with color naming) is easier to demonstrate. The Stroop effect remains a mystery; much is still unknown about the location of the interference; whether it occurs during input or output, during processing, or during identification; whether the interference occurs from involuntarily reading the word or being unable to ignore it. Researchers typically think of the Stroop effect as a perceptual phenomenon that distracts the reader by providing

interference; it is also perceptual in what is believed to be the cause, location, and amplification of its interfering effect.

Rapid Serial Visual Presentation

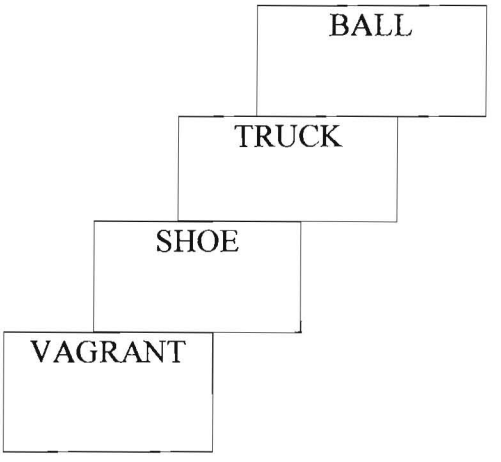
Rapid Serial Visual Presentation (RSVP) is a process in which a researcher presents words, phrases, or letters in succession to a reader on a computer screen (Young, 1984). Each word, phrase, or letter remains on the screen for a specified amount of time. That specified amount of time is known as Stimulus Onset Asynchrony (SOA). When one stimulus is removed and another is presented on the screen, there is some time elapse. The amount of time that passes is called the Interstimulus Interval (ISI). Researchers utilize these techniques as they explore various ways to implement RSVP procedures. Raymond, Shapiro, and Arnell (1992) found that as SOA increases, proportion of correct response increases. McLean, Broadbent, and Broadbent (1983) discovered that as ISI increases, the number of errors decreases.

RSVP is a technique that has started to gain prominence outside the experimental laboratories. For example, specialists use RSVP to detect subtle differences in reading strategies, and advertisers use RSVP to increase people's attention.

In an RSVP task, the reader or observer looks at a fixation point at a specified location on the screen. In research, the screen is a computer screen; in advertisement, the screen is a television set. The reader sees a "stream" of words that are presented sequentially at the same fixation point. The theory is that

because the reader does not have to make eye movements, left to right and top to bottom, the reader should be able to retain more information of the stream that is being read. RSVP techniques can be thought of much the same way as "flashcards." When using flashcards, the reader sees one word or phrase on one side of the card. The reader might have many cards with words or phrases on them, replacing the present card with the next card in the sequence. RSVP techniques are also similar to flashcards in that the words on flashcards are presented at the same location on each card, much like the fixation point in RSVP techniques.

When mapped out, RSVP streams can look like this:



where each word will be presented serially, or sequentially. The reader is instructed to concentrate on one fixation point while attending to the words at that point.

Initially, researchers demonstrated that RSVP was a useful tool for reading text. According to Juola (1987), RSVP is useful both as a tool for studying

reading processes and as a way to improve reading efficiency. According to Juola, because so much of what is read today is presented on computer screens, it is important to learn how to best present the text that we read on the screen. Raymond, Shapiro, and Arnell (1992) suggest that RSVP is a visual search task that operates in the temporal rather than the spatial domain. Thus, according to Raymond et al., RSVP can be a useful tool when examining the characteristics of perceptual and attentional processes. Both Juola (1987) and Chen (1986) have suggested that RSVP could be improve reading comprehension. Juola stated that one reason some people are classified as "low-level" readers is because frequent eye movements decrease comprehension. RSVP requires no such eye movements. When read in a "normal" format (left to right, top to bottom), eyes move left to right, and top to bottom. Juola (1987) suggests that valuable information is lost when readers are required to perform such regular eye movements. Chen (1986) suggested that irregular regressions (i.e., rereading the same line) and mislocations of line beginnings (i.e., starting a line of text with the third word in the line) can have a negative impact on reading comprehension.

Still, the RSVP technique is new and for the most part, is used only in the laboratory. Much is still unknown about this "tool;" for instance, what is the optimal speed at which RSVP displays should be read?

Although some disagreement on the optimal speed of RSVP exists, most researchers believe that each stimulus in the RSVP display should remain on the screen for between 100-900ms. Juola (1987) stated that an SOA of 500ms yielded

a reading rate of 300 words per minute (WPM). Juola, Ward, and McNamara (1982) reported that a reading rate of 300 WPM was average for adult readers.

Another problem facing researchers has been the question of how many words should be presented in each RSVP segment of text. The number of words in each segment of text determines its "window size." Juola (1987) found that the optimal window size for RSVP segments was between 12 and 13 characters long. Cocklin, Ward, Chen, and Juola (1984) also reported that the maximum number of characters an RSVP display should have is 12. Yet another concern of researchers has been the location of text on the screen in an RSVP display. Young (1984) suggested that when the RSVP text segment moves from location to location on the screen, the reader must perform the same sorts of eye movements that plague normal reading. However, if the text remains stationary, the eye movements are eliminated.

Maki, Frigen, and Paulson (1997) conducted an experiment in which participants reported the identity of one of two target words. They found that identification of the first target word caused an impairment for identification of the second target word. In their experiment, Target 1 (T1) and Target 2 (T2) were both capitalized words, whereas the remaining filler items were lowercase words. They also found that if the content or word meaning between T1 and T2 was similar, participants were more likely to correctly report T2. When T1 and T2 are similar, this effect is known as "priming." If there is a link or connection between T1 and T2, recall of T2 should be more accurate. Seiffert and Di Lollo (1997)

found that if the task is to report the identity of T1 and T2, and the participant correctly identifies T1, an attentional blink could result which lasts for several hundred milliseconds. Thus, the participant could "miss" the next word in the sequence. If the researcher uses lag times, the attentional blink becomes an important factor. If T2 appears immediately after T1, and the participant is distracted by the presence of T1 when T2 is the to-be-reported stimulus, the participant is likely to miss the presence of T2, and therefore cannot report its identity.

Chun (1997) reported two types of errors that participants often commit when they engage in RSVP tasks. The first error is called a pretarget intrusion. Pretarget intrusions occur when the participant becomes distracted by the item preceding the target item. The participant becomes confused, and reports the identity of the preceding item. Posttarget intrusions occur when the participant is distracted by the item appearing after the target item, and mistakenly reports the identity of the posttarget item.

Peterson and Juola (2000) found that the effects of the attentional blink are most prominent when T2 occurs within 500ms of T1. In the present experiment, T2 appears within 500ms of T1 75% of the time. If T2 is not correctly reported at the first three lag positions, one possible explanation could be the presence of the attentional blink. However, we would expect T2 to be reported more often at the fourth lag (T2 + 5) because the "gate" has opened and the effects of the attentional blink have diminished. Juola, Duvuru, and Peterson (2000) found that

when T2 immediately follows T1, the T2 item interferes with T1 and is thus not reported correctly as often as when T2 is preceded by a number of filler items. Thus, not only is there a lag effect but also an effect from the presence of the attentional blink.

The Stroop effect in RSVP

Although not directly related to the Stroop effect, Botella, Garcia, and Barriopedro (1992) presented their experiment in an RSVP stream with the words in color. The filler items were shown in lowercase letters, and one word (the target word) was in all uppercase letters and inserted into the middle of the stream. Participants were divided into four groups and asked to report the identity and/or color (ink) of the target word. Their results indicated that color responses showed a systematic predominance of post-target intrusions. They found significant differences in all three domains: when the participant was to report the color only, the color then the word's identity, or the identity and then the color. Botella et al. found that when the task was to identify two targets, participants made more errors than when the task was to identify one target. The location relative to the target also played a role. Botella et al. discovered that participants committed more errors on words closer to the target. This finding lends further weight to the attentional blink and to the attentional gate.

Summary

The Stroop effect is a perceptual phenomenon that serves to distract the reader by providing interference with a person's ability to identify colors. The

location of the interference is thought to be between the encoding and retrieval stages of information processing. Although researchers have thoroughly investigated RSVP, little is known about its usefulness when looking for evidence of a Stroop effect. RSVP serves as a research tool, and a reading aid to assist low-level readers. I conducted the present study to demonstrate that RSVP is useful when analyzing the differences between normal left to right, top to bottom reading and RSVP reading. In the present experiment the SOA and ISI remained constant at 120ms and 0ms, respectively. The window size for each segment of text will vary from between 3 and 9 characters. The position at which the text appeared also remained constant throughout the experiment; each word in the stream was presented at the center of the screen and used two target words. Because the participants reported the color (ink) of the second target word, the second target word's relation to the first target word was important; the attentional blink and the attentional gate can affect the participant's response. Because the present participants identified color, some compensation for the preceding and succeeding items was needed. This goal was accomplished by converting the intervening filler items (items between T1 and T2) into one, previously unused color. This procedure eliminated any pretarget intrusion errors, except those errors made when T2 appears immediately after T1. This potential problem was eradicated by placing a series of six white X's between T1 and T2 for a time of no more than 50ms.

Hypotheses

Hypothesis 1

Hypothesis 1 predicted that a Stroop effect would exist in Rapid Serial Visual Presentation (RSVP). That is, word recognition would interfere with color-naming ability in an RSVP stream.

Hypothesis 2

Hypothesis 2 predicted that as lag time increased, the proportion of correct responses would also increase. That is, the farther away from each other the two target words are, the more likely the participant would respond correctly.

CHAPTER 2

METHOD

Participants

Students at Emporia State University were participants. In order to ensure adequate statistical power, the minimum number of participants needed for this experiment was 20. Therefore, 23 women and 8 men participated in this experiment. Participants received one research point for their psychology class. All participants were tested according to the American Psychological Association (APA, 1992) ethical standards.

Design

The proportion of correct responses served as the dependent variable. The proportion of correct responses was calculated by dividing the number of correct responses in each of the 32 cells by the total responses in each cell. The independent variables were T1-T2 ink, T1-T2 word, T2, and lag. T1-T2 ink was manipulated by having the ink of the T1 and T2 words either the same or different. T1-T2 word was manipulated by varying the congruency of the word that T1 and T2 were presented in. T2 was manipulated by having the word and ink that T2 was presented in be the same or different. Lag was manipulated by varying the distance between T1 and T2. The four lag positions were T1+0, T1+1, T1+3, and T1+5. T2 appeared either immediately following T1, following the first filler after T1, following the third filler after T1, or following the fifth filler after T1.

Apparatus

The computer used for this experiment included a 19-inch BTC monitor. The keyboard was located to the right of the participant in front of the experimenter; the computer tower was located on a chair to the right of the table that held the monitor. The words were displayed using a 12-point Monaco font.

Procedure

After signing the informed consent document (see Appendix A), participants were shown to a seat in front of the monitor. The overhead light was turned off and the participants were given the instructions while their eyes adjusted to the change in lighting. The only light in the room was from the computer screen and a 60-watt table lamp located underneath the table. The location of the lamp eliminated any possible glare on the screen and allowed the participants to focus their attention on the task. Because of the small size of the testing room, a fan was positioned behind the experimenter and turned on before each session began.

After the instructions were read, the experiment began. Each participant was presented with a 20-frame RSVP stream. Two of the words were targets (T1 and T2) and were presented in all uppercase letters and were the color names, red, blue, green, or yellow. The filler items (see Appendix B) were presented in all lowercase letters. The filler items, T1 and T2 were shown or presented in red, blue, green, or yellow ink. Target 2 appeared immediately after T1 or after 1, 3, or 5 filler items. If there was a space between T1 and T2 the intervening filler items

were shown in white. Showing the intervening filler items in white eliminated any possibility of the color of a filler item interfering with the naming of T2. Each participant verbally reported the ink color (the color that the word is presented in) of T2 only.

To begin the experiment each participant pressed the space bar. A fixation point, a series of 6 horizontally displayed X's, appeared briefly to cue the position of each RSVP stream. This fixation point remained in the same relative position on the screen throughout the entire experiment. After the participants verbally reported their response, the recorder entered the response on the keyboard by pressing one of four designated numbers.

Each session began with 15 practice trials and consisted of 256 additional experimental trials. A break that lasted as long as the participant wished was presented halfway through the experimental trials. The participants were allowed the option to leave the testing room during the break. When the participant was finished with the break, the recorder pressed the spacebar to proceed to the next trial.

CHAPTER 3

RESULTS

This study explored the possibility that a Stroop effect existed in Rapid Serial Visual Presentation. The purpose of this study was to better understand the mechanisms that are present in RSVP tasks. The color of the word (ink) that each target word was presented in, the target words themselves, the second target word and the ink it was presented in, and the distance between the two target words were manipulated to aid in the understanding of these mechanisms.

The statistics used for this study were calculated using the Statistical Package for Social Sciences Base (SPSS) 7.5 for Windows. An alpha level of .05 was used to determine statistical significance. A 2 x 2 x 2 x 4 repeated measures (all within variables) analysis of variance (ANOVA) determined if significant differences existed. Table 1 presents the main effects of the ANOVA.

The hypotheses for this study were as follows:

1. A Stroop effect exists in Rapid Serial Visual Presentation (RSVP).
2. As lag time increases, the proportion of correct responses will also increase.

Statistical analysis revealed that there was a significant difference between the congruency of the ink of T1 and T2 (see Figure 1). Thus, proportion of correct responses was significantly different when T1 and T2 were presented in the same ink as opposed to different ink. This finding supports the first hypothesis. A significant difference was also found in the congruency of T2 (see Figure 2). That is, when T2 was congruent across word and ink the proportion of correct

responses was significantly different than when T2 was incongruent. This finding supports the first hypothesis. No significant difference existed between the congruency of word between T1 and T2. The statistical analysis revealed a significant difference for lag (see Figure 3). Thus, the proportion of correct responses was significantly different between lag times. This finding supports the second hypothesis.

The statistical analysis revealed only one significant interaction among the variables. That significant interaction was between ink and lag (see Table 2). This significant difference means that the proportion of correct responses varies according to the lag position of T2 and whether T1 and T2 are congruent or incongruent across ink (see Figure 4). This finding supports both hypotheses. Figures 1-4 represent scores obtained by collapsing the data across all participants and calculating the mean of each effect.

Table 1

Summary of Analysis of Variance for the Main Effects of the Independent Variables: Word, Ink, T2, and Lag.

Source	df	SS	MS	F
Word	1	5.30	5.30	1.61
Error (Word)	30	98.50	3.28	
Ink	1	116.50	116.50	27.17**
Error (Ink)	30	128.70	4.29	
T2	1	40.30	40.30	5.55*
Error (T2)	30	218.20	7.27	
Lag	3	71.00	23.70	8.87**
Error (Lag)	90	240.20	2.67	

* $p<.05$

** $p<.001$

Table 2

Summary of Analysis of Variance for the Interaction of the Independent Variables: Ink and Lag

Source	df	SS	MS	F
Word * Ink	1	.00	.00	.17
Error	30	.88	.00	
Word * T2	1	.00	.00	.29
Error	30	1.12	.00	
Word * Lag	3	.14	.00	1.40
Error	90	2.98	.00	
Ink * T2	1	.00	.00	.50
Error	30	.97	.00	
Ink * Lag	3	25.40	8.47	2.77*
Error	90	275.10	3.06	
T2 * Lag	3	.01	.00	1.38
Error	90	2.17	.00	
Word * Ink * T2	1	.01	.01	1.71
Error	30	.93	.00	
Word * Ink * Lag	3	.01	.00	.86
Error	90	2.63	.00	

Table 2 (continued)

Source	df	SS	MS	F
Word * T2 * Lag	3	.00	.00	.24
Error	90	2.50	.00	
Ink * T2 * Lag	3	.00	.00	.25
Error	90	.00	.00	
Word * Ink * T2 * Lag	3	.00	.00	.12
Error	90	2.38	.00	

* $p<.05$

Table 3

Summary of Means and Standard Deviations for the Significant Main Effects

Main Effect	n	M	SD
Ink Congruent	31	.45	.04
Ink Incongruent	31	.38	.07
T2 Congruent	31	.44	.06
T2 Incongruent	31	.39	.07
Lag 1	31	.39	.06
Lag 2	31	.40	.06
Lag 3	31	.43	.07
Lag 4	31	.40	.07

Figure 1

Ink Effect-Congruent vs. Incongruent Across T1 and T2

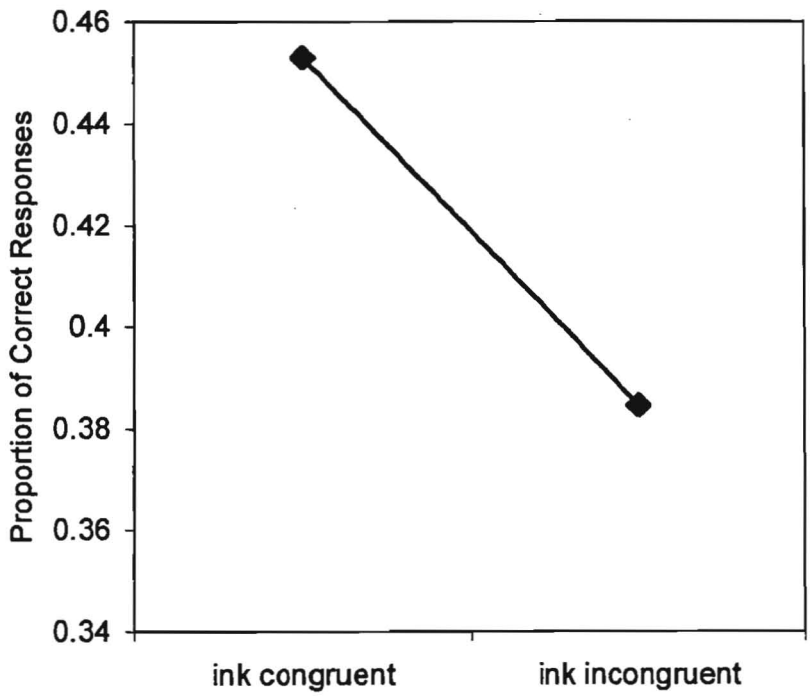


Figure 2

T2 Effect-Congruent vs. Incongruent

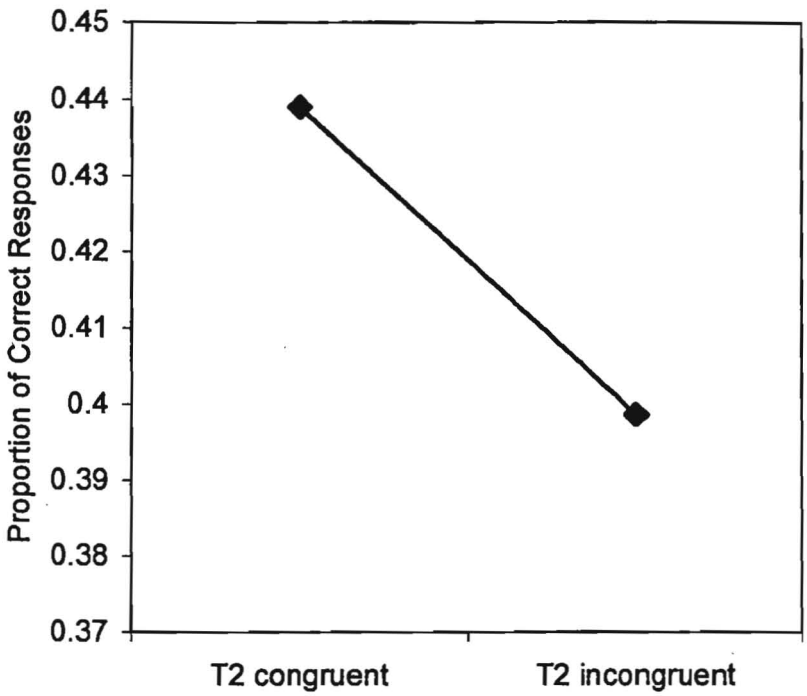


Figure 3

Lag Effect-Differences Between Lag 1, Lag 2, Lag 3, and Lag 4

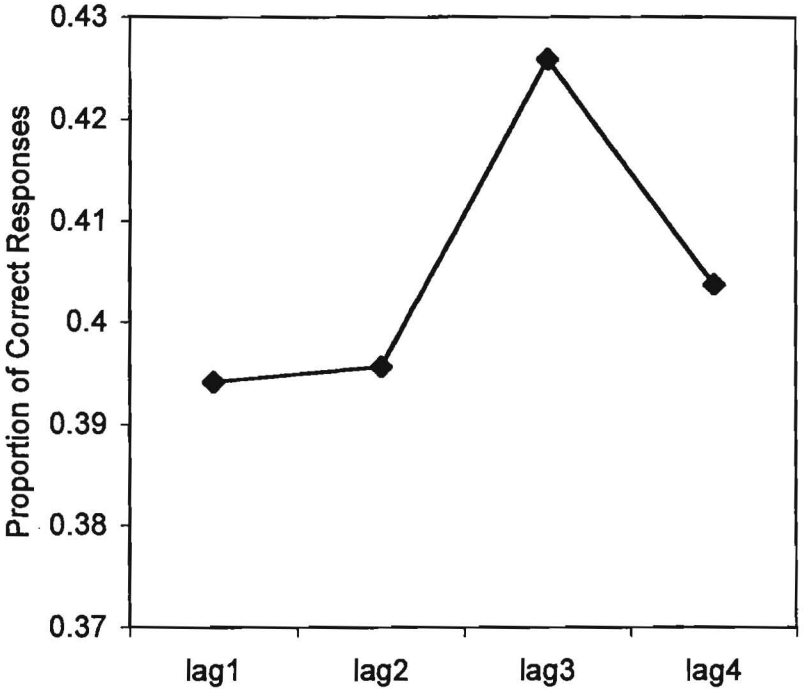
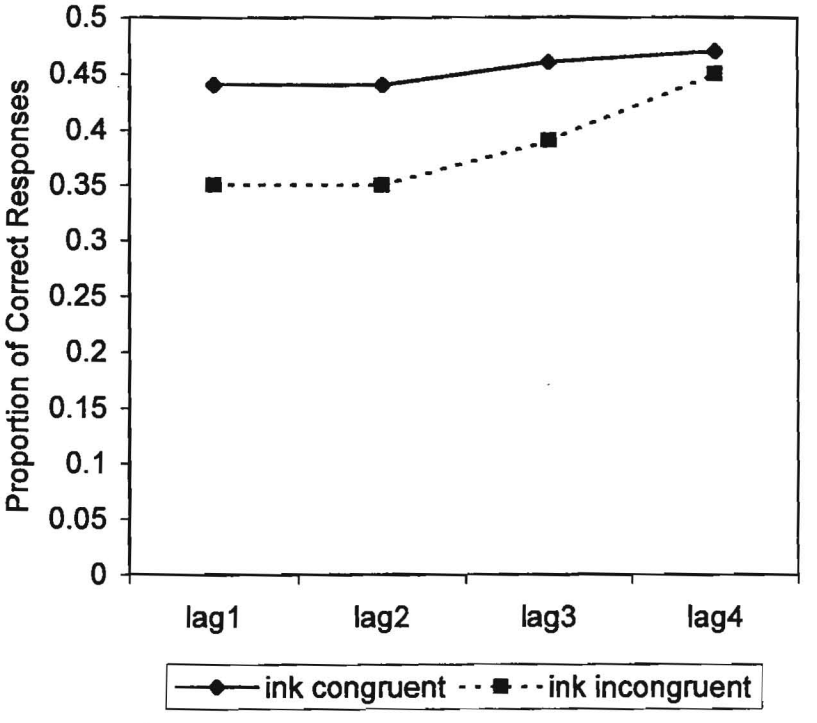


Figure 4

Interaction Effect-Ink and Lag



CHAPTER 4

DISCUSSION

The results of this study indicated that a Stroop effect exists in Rapid Serial Visual Presentation. This result supports Hypothesis 1. The results further demonstrated evidence of the Attentional Blink and the Attentional Gate. Evidence of the Stroop effect can be found by looking at the statistical significance of the Ink main effect. The results indicate that the ink that T1 and T2 are presented in affects participants' responses. The proportion of correct responses was higher when ink is congruent across T1 and T2 as opposed to when ink was incongruent. Therefore, the interference of incongruent stimuli results in a lower proportion of correct responses when ink was incongruent across T1 and T2. It is this interference that past researchers have claimed to be the Stroop effect. Stroop (1935) stated that the relevant interference was that of word meaning interfering with color naming. The significant Ink effect demonstrates that the congruency of the ink can also interfere with the ability to name the color that a Target word is presented in.

Whether T2 was congruent across word and ink was also found to be statistically significant. The proportion of correct responses was higher when T2 was congruent across word and ink than when it was incongruent. Thus, further evidence of the Stroop effect is demonstrated by the interference of incongruent stimuli. This result supports Stroop's (1935) claim that word meaning interferes with color naming ability.

The lag effect was also statistically significant. This result supports Hypothesis 2. Although not related to the Stroop effect, the importance of lag has been shown in studies utilizing multiple targets. Lag is the distance (time) between T1 and T2; and it is this distance that researchers have used to study the Attentional Blink and the Attentional Gate. According to a study done by Maki, Frigen, and Paulson (1997) the Attentional Blink can be observed by presenting two target words and manipulating the distance between them. At shorter intervals, that is, when T1 and T2 appeared close together, participants had a more difficult time identifying T2 than when T1 and T2 were separated by a longer interval. Thus, when processing information, participants' attention "blinked" after locating the first Target and therefore missed the presentation of the second Target which occurred during the Attentional Blink. The present findings support the theory of the Attentional Blink and that of the Attentional Gate because the proportion of correct responses increased as lag increased.

The interaction between ink and lag was statistically significant. Proportion of correct responses was higher when ink was congruent across T1 and T2 and was higher as lag increased. These findings support evidence that the Stroop effect is subject to the Attentional Blink. This support is demonstrated by looking at the difference in proportion of correct responses across lag and ink. At shorter lag times (lag1, 2, 3), and when ink is incongruent, the proportion of correct responses parallels the proportion of correct responses when ink is

congruent. However, at lag 4 proportion of correct responses for the ink incongruent condition is almost identical to that of the congruent condition.

Implications

Rapid Serial Visual Presentation has been shown to be useful as a reading aid and as a research tool. If RSVP is to be used to aid in the comprehension of low-level readers, then we must first begin to understand the different mechanisms that are at work in RSVP reading. The present findings demonstrate that RSVP involves some of the same mechanisms that are at work in normal reading. One of those mechanisms is the Stroop effect. This study provides evidence that at least one of the mechanisms in RSVP reading is similar to that mechanism in normal reading. Thus, more information is now known about RSVP and researchers can utilize this study to further identify more mechanisms that are at work in an RSVP task.

If technology continues to progress, and more and more people are sitting behind computer screens for a longer amount of time, RSVP could be beneficial when it comes to determining the optimum way to read at a computer screen. RSVP could eventually replace if not enhance normal reading when it comes to computers. This shift in procedure would allow low-level readers a chance to further optimize their reading potential. It would also provide a more efficient way of reading a computer screen, a way that does not require eye movements. This use could also impact the medical field--many researchers are trying to determine how best to counteract the effects of fatigue on the eyes as we read at

computer screens. All of these possibilities exist, and if our task is to provide answers to these questions, then we must begin by studying the basic elements of RSVP.

Limitations

This study has several limitations. First, all of the participants used had normal, or corrected-to-normal vision. This feature limits the population that the results can be generalized to. However, because most of the population has normal, or corrected-to-normal vision, this limitation is small. Second, because all of the participants were not color-blind, this aspect further limits the population that the results can be generalized to. A significant portion of the overall population is color-blind, and therefore, would not be subject to the same results. Another possible limitation of this study is the fact that all participants were young men and women with no significant vision problems. The results of this study might not generalize well to an older population or to a population with a significant amount of vision impairments.

Future Research

As noted earlier, the only way to further knowledge in the realm of RSVP is to study it. This study provides an outline for further research in the area of RSVP. First, what mechanisms are at work in normal reading? Then researchers can begin to formulate hypotheses as to the existence of those mechanisms in an RSVP task. Next, researchers can design an experiment to test those hypotheses.

Finally, researchers can analyze the data and determine whether or not those mechanisms are actually at work in RSVP tasks.

Many questions still remain about the mechanisms that are at work in RSVP tasks. Some of those questions revolve around the possible usefulness of RSVP. If the RSVP technique is to be used to aid in reading comprehension, then researchers must first understand how RSVP works and what its limitations are. Researchers must also identify differences between RSVP reading and normal reading. To accomplish this goal and answer all of the above questions, researchers must study this technique more thoroughly. That process starts with identifying the most basic elements that are at work in an RSVP task. Only by researching RSVP at its most basic components can researchers begin to answer some of the more complex questions surrounding this phenomenon.

Conclusions

This study provided evidence that a Stroop effect exists in an RSVP task. The results further demonstrate that the Attentional Blink and the Attentional Gate play a significant role in RSVP tasks that utilize multiple targets. The Stroop effect is subject to the effects of the Attentional Blink as shown by the relation between ink and lag.

The above conclusions demonstrate how useful the RSVP task can be. When attempting to identify differences between RSVP reading and normal reading, it is important to have a frame of reference. In this study the Stroop

Effect is that frame of reference. The Stroop effect has been widely researched; its validity has been demonstrated and supported many times. RSVP and the Attentional Blink have been studied as well. However, many questions surrounding RSVP and its usefulness still remain. To answer these questions requires continued study of the RSVP technique and an attempt to identify the basic elements that are involved in RSVP reading.

Facilitating new research in this area means looking at the mechanisms that are involved in normal reading. Only by identifying those mechanisms can a frame of reference for further research in the field of RSVP be determined.

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Appendix A

Informed Consent Statement

The Department of Psychology supports the practice for human subjects participating in research. The following information is provided so that you can decide whether you wish to participate in the present experiment. You should be aware that even if you agree to participate you are free to withdraw at any time without any penalty whatsoever.

The discomforts and or risks are minimal, however, your eyes might become tired. Although a break is presented half-way through, you can request a break at any time. The experiment should last approximately 30 minutes. This study is expected to demonstrate that a Stroop Effect exists in a Rapid Serial Visual Presentation (RSVP) stream.

You will be shown a horizontally displayed stream of words. Target 1, Target 2, and the filler items will be shown in either blue, red, green, or yellow. Target 1 and Target 2 are in all upper-case letters, while the filler items will be shown in all lower-case letters. Verbally report the ink color, not the word of Target 2.

Your participation is requested and is completely voluntary. Do not hesitate to ask questions about this study if something is unclear. Be assured that your name will not be used in any way with the research findings. We very much appreciate you cooperation.

Sincerely,

Seth Wescott	Stephen Davis, Ph.D.
Principle Investigator	Faculty Supervisor

"I have read the above statement and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask any questions I had concerning the procedures and possible risks involved. I understand the potential risks involved and I assume them voluntarily. I likewise understand that I can withdraw from the study at any time without being subject to reproach."

_____ _____

Signature of Subject Date

Appendix B

tooth	duck	mute
ache	pond	silent
drench	mower	casket
soak	flash	coffin
dog	camera	wit
puppy	glove	humor
mystery	mitten	gas
novel	sky	fuel
soda	cloud	shake
coke	lawn	rattle
saturn	planet	wind
blow	gallon	jug
eager	anxious	gem
jewel	porch	swing
throw	catch	belt
buckle	finger	thumb
shy	timid	sour
bitter	owe	debt
chain	link	myth
legend	dish	bowl
cheese	cracker	mob
gang	fist	punch
spill	mess	fury
rage	path	trail
battle	fight	jump
rope	alert	aware
picnic	basket	safe
secure	stove	oven
movie	theatre	yell
shout	quest	search
heel	toe	cow
calf	steel	iron
blame	accuse	toll
booth	bent	crooked
rely	trust	smooth
soft	rattle	hoe
rake	spare	extra
vagrant	bum	moist
damp	stalk	prey
cooler	ice	glide
fly	boat	sail
vision	sight	blade
razor	scared	afraid
dirty	filthy	shovel

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Seth L. Wescott

Signature of Author

5/6/01

Date

An Analysis of the Stroop Effect in Rapid Serial Visual Presentation

Title of Thesis

Signature of Graduate Office Staff

May 7, 2001

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