THE EFFECTS OF COLOR AND TYPEFACE

ON DIRECTED FORGETTING

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CHAPTER 1

INTRODUCTION

On some level, memory controls or directs one's very existence. It directs attention, evokes memories, and guides actions. Because one's memory determines existential reality, understanding the collective storehouse of knowledge casually called "memory" is of critical concern to anyone concerned with human behavior. Whether individuals act of their own accord or are motivated or directed to behave in a particular fashion, the presence (or absence) of memories and the cognitions associated with them have a decided impact on the outcomes exhibited. Of particular concern to many individuals researching cognitive phenomena is not only the manner in which items are stored and subsequently remembered but the manner in which stored items are subsequently forgotten, accidentally or intentionally. Moreover, a particular branch of cognitive research is concerned with the fact that individuals often exhibit particular difficulty in forgetting items learned both with and (in some cases) without intentionality. This field of research, known variously by such titles as "directed forgetting," "intentional forgetting," and "directed ignoring," borrows from decay and inhibition theories of memory to explicate possible mechanisms at work in intentional disregard of memory traces. That is, research in directed forgetting seeks explanations for the often-imperfect ability of humans to forget by invoking suppression or decay mechanisms. It is not to be confused, however, with thought suppression. Whereas directed forgetting represents successful control of conscious thought, suppression is notoriously ineffective in achieving its aim, inhibiting memory for or expression of unwanted thoughts (Whetstone & Cross, 1998).

While removal of information from memory at first appears contradictory to the

very purpose of memory, the removal of irrelevant information from memory identifies one of its greatest feats, the ability to adapt to changing demands, that is, the ability to be updated. As early as 1890, William James noted the positive effects from removing items from memory as he mused “if we remembered everything, we should on most occasions be as ill off as if we remembered nothing” (James, 1890, p. 68). Despite this presumed necessity of data removal, humans do not always forget well, and with the exception of those with unusual mental conditions most people do not complain about the inability to remove information from memory. More frequently, we complain about the inability to remember information. According to Bjork (1970), however, the two problems are likely to be related. Specifically, Bjork states:

> When people voice complaints about their memory [sic], they invariably assume that the problem is one of insufficient retention of information. In a very real sense, however, the problem may be at least partly a matter of insufficient or inefficient forgetting. (p. 265)

Perhaps if humans were more like computers in at least the data-removal respect, they would be able to enhance their memory abilities. As Bjork (1970) put it:

> Computers handle the problem in a straight-forward if somewhat drastic way. When new information is read into a location in memory, old information at that location is destroyed. Whatever the analogous human mechanism, it is certainly not so simple, nor so complete. (p. 265)

While humans must contend with that which is often perceived as an imperfect system, gaining an understanding of these imperfections can yield insight into all

cognitive mechanisms which comprise the elusive structure known as the mind. To this end, research directed toward understanding of an individual's ability to remove an item from his/her memory through sheer volition or intentionality has not waned over 40 years though its emphasis has shifted slightly from time to time to emphasize new research findings.

The phenomenon known as directed forgetting or intentional forgetting has been studied extensively, with the first study generally attributed to Bjork, LeBerge, and LeGrand (1968). Since the publication of this article, a variety of well-documented effects have contributed to our understanding of the manner in which individuals execute instructions to remember and forget items encountered each day. Nonetheless, the phenomenon is not completely understood, and differing theories exist to explain the differential effects of two commonly used methods of testing for directed forgetting effects. Despite the fact that a large literature exists regarding the effects of the direction to forget on subsequent memory for items learned, these studies have focused little attention on the effects of various visual stimuli which might enhance or impair an individual's ability to remember (or forget) a previously viewed item. The effects of color have been examined, however, in studies of perceptual priming (e.g., Hupbach, Melzer, & Hardt, 2006), and arousal (e.g., Farley & Grant, 1976), and color has been shown to operate differently depending on the requisite processing of the task. Color even has been demonstrated to affect differentially the motivation of individuals to click on a hyperlink embedded in an email (Zviran, Te'eni, & Gross, 2006).

Statement of the Problem

Though color was used in one of the earliest directed forgetting studies (Bjork, 1970), its presence in this and subsequent studies served only as a direct signal to switch from remembering to forgetting subsequent words and not as an inherent quality of print designed to make the words more or less memorable. That is, while Bjork used words printed on either green or yellow backgrounds, a change in background color functioned only as a direct signal to the participants that upcoming words were either to-be-remembered [TBR] or to-be-forgotten [TBF] words. The colors (e.g., green and yellow) served no meaningful purpose related to the colors themselves. The words could just as easily have been printed in black on white backgrounds or in black on white backgrounds and thereby have served the same function as envisioned in Bjork's research. To the credit of this line of research, however, alternating between two different background colors did at least pose the possibility of a contrast effect. Nonetheless, no such effect was reported by the researchers. Though such an effect is plausible, its absence from the Bjork (1970) study is likely due to the fact that each color was used to present exactly one-half of the words to the participants and then only as an explicit signal to forget. One must remember, nonetheless, that it was not the express intent of the author to demonstrate a salience effect for color on memory. Quite a different outcome might have been observed had word color, not background color, been used deliberately to investigate differential responsiveness to colors during a directed forgetting exercise. In fact, research has demonstrated that the color red can have a negative impact on performance attainment on written tests and has been linked to avoidance motivation in

certain tasks (Elliot, et al, 2007). Thus, understanding the relationship of color of printed material to subsequent recognition or recall of that material is important to understanding the directed forgetting phenomenon.

In addition to the potential salience effect(s) of color on memory of previously viewed words, typeface (e.g., ARIAL versus TIMES NEW ROMAN) may also possess a similar potentially biasing effect in directed forgetting exercises. As noted in a study of the effects motivation to respond to email, type font may also be equally important (Zviran, Te'eni, & Gross, 2006). Thus, research is also necessary to determine the effects, if any, of typeface on subsequent memory for previously viewed printed material.

Purpose of the Study

The purpose of this research is to extend the literature on the phenomenon known as directed forgetting. Despite the fact that individuals are sometimes successful and sometimes unsuccessful at forgetting when instructed to do so, research has not adequately addressed the potential impact of presentation format on the directed forgetting process. One only need examine a textbook or a web document to find myriad examples of the use of distinctive color and typeface intended to capture the attention of the reader. With this increasing reliance on distinctive visual stimuli to catch the attention of readers of printed materials, the effectiveness of color as well as typeface must be considered as relevant to a complete understanding of the manner in which individuals are affected by various visual stimuli chosen for the presentation. To facilitate this understanding, this study will be conducted to identify the potential

differential effects of font color and typeface on an individual's ability to forget lists of words which have been viewed before and after an instruction to forget some previously viewed words. This project is predicated on the specific finding in other research domains that color has a differential impact on performance in memory tasks. Further, this research investigates the possibility that color and typeface leave memory traces that are either more or less likely to be remembered despite a specific instruction to forget these items.

While previous explanations of the directed forgetting phenomenon have relied exclusively on cognitive theories to explain the directed forgetting effect, this study posits a potential perceptual mechanism which may partially account for the inability of individuals to forget items when instructed to do so. That is, the character of visual stimuli may make it more or less possible for an individual to remove from memory items previously viewed. The viewer is likely, in fact, to be completely unaware of the impact of such distinctive phenomena on his/her ability to forget because it is likely that it the impact stems from a perceptual rather than cognitive processing.

Significance of the Study

This research could contribute significantly to existing knowledge regarding an individual's ability to forget items previously viewed. More precisely this research contributes to our understanding of the persistent effects on memory of differentially printed materials which an individual is able or is not able to overcome through the explicit instruction to disregard or to forget the material.

While this research might initially appear only to address the interference of

competing perceptual stimuli in a time-restricted, cognitive resource efficiency task (e.g., a phenomenon such as the Stroop effect), this research probes a distinctly different phenomenon. While the Stroop effect in general represents the immediately confounding effect on mental resources of naming the color of a viewed word which is either an unrelated word or an oppositional-color word, this research probes the memory trace of words printed in color and distinctive typefaces. That is, this research is designed to examine the consequence for memory (a long-term effect) rather than immediate expression (an immediate resource competition effect).Though this research might initially appear only to elucidate further one's understanding of the interference of competing perceptual stimuli in a time-restricted, cognitive resource efficiency task (e.g., a phenomenon such as the Stroop effect), this research probes a distinctly different phenomenon. The Stroop effect in general represents the immediately confounding effect on mental resources of naming the word or the color name of a word presented in either the same or the oppositional-color presentation. That is, the color green, for example, is easier to name when the target word "green" is printed in green rather than a color other than green. Despite the emphasis on color in such research, this research probes a different aspect of color presentation. Specifically, this research investigates the longer-term memory trace of words printed in color, not the immediate impact of color on naming a word. In short, this research is designed to examine the potential lingering impact on stored memories (a long-term effect) of a visual display rather than the competing-resources impact of a task demanding immediate expression of visual stimuli (a short-term effect).

The potential finding that color or typeface enhances or diminishes an individual's ability to forget what he/she has previously viewed would represent practical significance for presentation of textbook and other educational materials, webpages, and a host of other media regularly encountered on a daily basis. On a daily basis, individuals, especially students, are bombarded with myriad stimuli from textbooks, Internet webpages, PowerPoint presentations, overhead projections, text messages, and a host of other sources. The differential impact of color and typeface must be understood if one hopes to obtain maximum attention from his/her presentations to these readers.

Definition of Terms

The **directed forgetting** phenomenon is typically investigated with one of two types of methodologies or manipulations. (Three types actually exist, but two methodologies are typically used to study this phenomenon.[1]) The first method, the list method, requires the use of two groups of individuals, each group receiving slightly different instructions. The list method is characterized by presenting a list of words in random order to a group of participants who have received an initial instruction to remember as many of the words on the list as possible. After an allotted interval passes in which the participants presumably rehearse the words they are shown, a second list of words is presented, and participants are similarly instructed to remember the second list of words. This group is labeled the remember group because they are asked to commit to memory all the words seen. A second group of participants is also presented with two

1 A third method, simultaneous presentation, presents the word and the cue to remember or forget simultaneously. It could be operationalized as the direction to remember only the 3rd line of text, or only the words on green backgrounds. Bjork (1970) employed this method when presenting words on yellow and green backgrounds and instructing participants to switch from remembering to forgetting when the color changed.

lists, but between the two lists the participants in this condition are instructed to forget the first list of words and remember only the second list of words. Subsequently, both instructional groups are asked to remember (i.e., recall or recognize) both sets of words. A successful experimental manipulation would result in more words being recalled from the second list than from the first list. The benefit of directed forgetting is thus identified as better memory for list 2 than list 1 while the cost of directed forgetting is a poorer memory for list 1 (Sahakyan & Delaney, 2001; Liu, Bjork, & Wickens, 1999).

The second method of testing directed forgetting is the item method. Under this method, individuals view words consecutively, as in the list method, but without an initial or global instruction to remember or forget. The instruction to remember or forget appears as an added item during the presentation of each word, typically during the last few second of its display.

Research Questions

In accordance with the purpose of this research, the following research questions guided this investigation:

1. Does a significant main effect exist for (a) color, (b) font type, (c) presentation mode—list and method, or (d) task type—recall and recognition—for total correct responses on a directed forgetting test?
2. Do significant interactions exist between (a) color and font, (b) color and presentation mode, (c) color and task type, (d) font and presentation mode, (e) font and task type, or (f) presentation mode and task type for total correct responses on a directed forgetting test?

3. Does a significant interaction exist among (a) color, font, and presentation mode, (b) color, font, and task type, (c) font, presentation mode, and task type, or (d) font, presentation type, and task type for total correct responses on a directed forgetting test?
4. Does a significant interaction exist among color, font, presentation mode, and task type for total correct responses on a directed forgetting test?

Limitations

This research was limited in at least three respects. First, all participants for the research were selected from a single academic institution. Further, though participants were solicited from the entire student body of an academic institution, these volunteers did not represent a random sample of the entire student body of the institution. Despite these limitations, the results of this inquiry were not impaired in any meaningful fashion because the investigation undertaken did not impinge on issues peculiar to any particular educational domain. Third, participants were drawn from an institution of higher learning and are not likely to represent the intelligence level of the general population. However, the issues investigated in this study are common to all individuals who read printed material, view text on a computer screen, or read text from projections in any variety of formats (e.g., transparencies or PowerPoint slides) and are not limited to the experiences of individuals of exceptional intelligence.

Additionally, this study did not address the effects of different handwriting styles on subsequent memory for such material; further research would be necessary to establish the effects of such presentations on memories for items which were to be remembered

versus those to be forgotten.

Organization of the Study

This paper is organized as follows: The current chapter, Chapter I, presented an overview of the research domain, the identification of the problem, the purpose of the proposed study, and the significance of the research undertaken. Additionally, key terms and concepts relevant to an understanding of the domain investigated have been explicated. Chapter II represents a review of the relevant literature for this research. It contains an overview of findings gleaned from the laboratory as well as the naturalistic settings. Additionally, Chapter II provides a discussion of the various methods used to elicit the directed forgetting phenomenon as well as potential explanations for the effects observed. Chapter III presents the methodology that was used to complete this research. It includes a description of (1) the participants for the study, (2) the design to be employed, (3) the independent variables, (4) the dependent variable, and (5) the procedures to be employed. Chapter IV presents the results of the data analysis. Chapter V contains a discussion of these results, including conclusions drawn, practical implications of the results, and implications for future research.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this chapter is to provide a review of the literature relevant to the research proposed in this document. This review is divided into three major sections. First, the evidence collected from observations in naturalistic settings and from laboratory settings is presented. Second, methods of elicitation of the directed forgetting phenomenon commonly found in the directed forgetting literature are identified, explained, and evaluated for potential usefulness in this study. Finally, this chapter concludes with a summary which (1) highlights the salient findings in this body of literature, (2) identifies the limitations of prior research, and (3) identifies the need for further research in this area.

The Directed Forgetting Phenomenon

While potential mechanisms contributing to the phenomena eventually isolated as "directed forgetting" have been researched since the late 1960's[2] , a fairly standardized definition of directed forgetting did not emerge until many years later. Perhaps the best (i.e., most cited) delimitation of the phenomenon's boundaries was expressed by Johnson in 1994. In a classic paper on successful intentional forgetting, Johnson (1994) discriminated between intentional forgetting and spontaneous forgetting. Specifically, she noted that "intentional forgetting is … a motivated attempt to limit the future expression of [sic] specific memory content" (Johnson, 1994). Alternately, "spontaneous forgetting … occurs without motivation and regardless of the information's validity or relevance" (Johnson, 1994). These definitions capture the volitional nature of the directed forgetting process and draw a clear line of demarcation between that which humans do

2 See Murdoch (1969) for a discussion of proactive interference and retroactive interference on single paired associates.

automatically and that which constitutes a willful, intentional endeavor for a presumably valid purpose. Notwithstanding the clarity of this distinction, years of research have culminated in the expression of the desired consequence of this effect by noting that a "successful directed forgetting effect is evidenced [sic] by the apparent loss of to-be-forgotten relative to to-be-remembered information following explicit instructions to forget the former" (David & Brown, 2003, p. 211). Thus, not only is the phenomenon of interest volitional, it is evinced by demonstrating that which one is instructed to do: forget.

While research directed toward following an instruction to forget might seem trivial to the uninitiated researcher, such is not the case. This effect, while seemingly the result of mere "following instructions," is not always as easy to demonstrate as one might believe. In fact, scores of studies have demonstrated exactly the opposite effect. Examination of a few of these studies should be sufficient to demonstrate the ubiquitous nature of the phenomenon.

Evidence from the World around Us

Social Judgments. Research outside the laboratory has clearly demonstrated that individuals are frequently unable to disregard information previously encountered. For example, it is often impossible to ignore or not be biased by information presented in court though jurors have been given explicit directions to ignore specific elements of the proceedings (Edwards & Bryan; 1997; Kassin & Sommers, 1997). Mock jurors also exhibit the same tendency (Thompson, Fong, and Rosenhan, 1981). Additionally, pretrial information often exhibits a similar pervasive, persistent nature (Fein, McCloskey, &

Tomlinson, 1997). Furthermore, information often becomes increasingly difficult to ignore as the information becomes more emotionally laden, thus producing a "boomerang effect" (Edwards & Bryan, 1997). That is, an effect exactly opposite the desired effect occurs: the information is remembered and considered when making a decision. A particularly poignant example of being unable to remove previous information from one's memory comes from the Hawaiian Punch case of R.J. Reynolds Company. Even after 10 years of advertising to correct a deliberate miscommunication regarding the "7 natural fruit juices" in Hawaiian Punch, a marketing research firm concluded that "30% of the consumer market still held false impressions about the actual fruit juice content of Hawaiian Punch" (Wilkie et. al., 1984). Thus, not only is the inability to forget often robust, it is often persistently problematic in spite of ostensibly corrective actions.

Evidence from the Laboratory

Importance of Early Research. While research in the laboratory has demonstrated effects similar to those evinced in the "real-world" cases, nascent research in the laboratory (e.g., Bjork, 1970) focused on achieving successful directed forgetting effects rather than cataloging gross aberrations in behavior. Though aberrations were noted, the results typically were small, and the importance of such aberrations, when compared to real-world examples, perchance negligible. However, the importance of the multitude of laboratory studies lies not in their magnification of effects observed in word-completion or stem-completion tasks but in their elucidation of normal occurrences. In fact, the laboratory studies are arguably more important than the "real-world" studies in that they bring us closer to understanding the operations of the brain and help us model

its capacities for daily activities. These studies of behavior both inside and outside of the laboratory contribute to our understanding of the mind.

Initial Mechanisms

One can reliably state that laboratory research on directed forgetting was inspired by the seminal work of Robert Bjork (1970). In this initial work, Bjork described a set of experiments designed to show the positive effects of directed forgetting on memory—presumably, precisely what an efficient memory system would require (Bjork, 1970). The result of this work was a theory of intentional forgetting that spawned over 40 years of research. Citing works in interference theory and decay theory, Bjork outlined a theory of positive forgetting that encompasses two main precepts. He proposed that individuals use the direction to forget in two ways. First, individuals use the direction to forget to categorize incoming data into two functionally separate groups: (a) to-be-remembered data/words, and (b) to-be-forgotten data/words. Second, the individual then brings "all rehearsal, mnemonic, and integrating activities following the forget instruction" to bear on the information to be remembered (Bjork, 1970, p. 266). Thus, the notions of set differentiation and selective rehearsal were born. Perhaps most important, however, is Bjork's (1970) assertion that differential rehearsal could not be a complete explanation of the directed forgetting effect. By observing that "forget" items were still among the words appearing on explicit tests of subjects' memories, he found evidence that the to-be-forgotten items were not completely eliminated from memory traces. Therefore, these items had been encoded despite the instruction to forget them, and differential rehearsal could only be a partial explanation of the effect.

Though relatively few articles were published in the 1970's as a result of Bjork's early work, those works which were published focused primarily on establishing a parsimonious, yet elegant explanation for a successful directed forgetting effect. That is, research had clearly demonstrated that a direction to forget could be effective, but how this occurred was yet unknown and eliciting it routinely was neither assured nor completely understood when it did occur. The prevailing explanation of the time—Bjork's set differentiation and differential rehearsal hypothesis—was increasingly criticized for its inability to explain the effect in sufficient situations to qualify as both a parsimonious and a robust theory. While researchers continued to investigate Bjork's theory (MacLeod, 1975; Woodward et al., 1973), a debate quickly ensued regarding the ability of the differential rehearsal hypothesis to serve as an explanatory mechanism for the directed forgetting effect in a variety of tasks.

Gleanings from Animal Research

Many studies published since Bjork's initial paper have demonstrated the directed forgetting phenomenon under a variety of circumstances. Though it might seem odd, researcher on animal behavior has demonstrated the directed forgetting effect with pigeons (Santi & Savich, 1985; Jitsumori, Taneya, & Kikawa, 1992; Roper & Zentall, 1993; Roper, Champonis, & Blaisdell, 2005) and rats (Miller & Armus, 1999).[3] Despite the obvious differences (and difficulties) involved in operationalizing such a study using animals, this research has identified explanatory mechanisms which are not altogether different from those offered as explanations for human performance in directed forgetting studies. Specifically, (1) decay of the stimulus, (2) interference of other stimuli, and (3)

3 See Roger & Zentall, 1993, for a review of these studies.

loss of sense of temporal order of cues have all been advanced as explanations of similar behavior patterns in animals (Roper & Zentall, 1993). Though humans may suffer as a result of these effects, most studies of human behavior have focused on the conditions under which the directed forgetting effects (or aberrations) could be elicited. That is, memory decay, signal interference, and loss of temporal order have generally been investigated as outcomes which are desirable under certain circumstances.

Contradictory Findings

Despite the fact that the positive effects of forgetting are of primary concern to most researchers, comparisons have been made between the desirable effects of directed forgetting and similar manifestations arising under exceptional human conditions. In research focusing on women with borderline personality disorders coupled with a history of parental abuse, Cloitre, Cancienne, Brodsky, Dulit, & Perry (1996) found that participants in a directed forgetting exercise exhibited greater ability than the control group members to remember words they were explicitly instructed to remember. Cloitre, et al. suggested that this superior memory performance could be a coping strategy. Similarly, Myers, Brewin, and Power (1998) demonstrated that individuals possessing a repressive coping style were superior to a control group at directed forgetting. This finding suggests that individuals who use repressive coping mechanisms may have a superior volitional ability to inhibit retrieval of elicited responses. Further, those with acute stress disorder also exhibit enhanced abilities to forget aversive material, and the severity of the disorder is negatively correlated with the ability to remember positive words which they had been instructed to remember (Moulds & Bryand, 2002). In

contradiction to these findings, however, several studies have shown that victims of trauma or abuse recall fewer positive and neutral words (McNally, Clancy, Metzger, Lasko, & Pitman, 1998) or more trauma-laden words (Korfine & Hooley, 2000) than their control group counterparts. Thus, research does not provide a clear picture of the effects of the instruction to forget for victims of trauma or abuse.

Aging

While literally hundreds of articles have probed the general relationship between memory and aging, only a modest number have specifically explored the relationship between aging and directed forgetting. In general, however, no clear-cut patterns of response unequivocally differentiate older participants from younger participants in studies of directed forgetting. For example, Salthouse, Siedlecki, & Krueger (2006) demonstrated a weak relationship between age and six different measures of memory control (one of which was directed forgetting), but Zellner & Baumi (2006) found no evidence of age-related deficits in directed forgetting in any of three experiments testing the directed forgetting effect. Nonetheless, some evidence suggests that at least recollection differences may be related to different encoding mechanisms employed by those of different ages (Perfect & Dasgupta, 1997).

Alternately, Dulaney, Marks, & Link (2004) found that younger adults were better at following the direction to forget than were older adults though increasing the interval between the memory cue (i.e., remember or forget) and the test for the effectiveness of the cue eliminated the advantage displayed by the younger participants. These findings are even more perplexing when compared to the finding of Harnishfeger & Pope (1996)

that children in the 1st, 3rd, and 5th grades were less able to inhibit to-be-forgotten words than members of an adult comparison group. It is important to note, however, that the older children did exhibit increased skill over the younger children at deliberately inhibiting recall of items previously directed to forget. Finally, when the instruction is to forget an action-related paired associate, however, the results seem clearer: both adults and children have difficulty forgetting action pairs after performing the actions though the children demonstrate a superior ability at forgetting paired associates which they previously have not performed but merely verbally encoded the item (Earles & Kersten, 2002).

Amnesia

Directed forgetting has also been studied from at least one additional unique perspective, posthypnotic amnesia (Geiselman, Bjork, & Fishman, 1983; Coe, Basden, Basden, Fikes, Gargano, & Webb, 1989). In general, the data collected in these studies support the conclusions that (1) retrieval inhibition is a possible partial explanation for the directed forgetting effect and (2) a yet-to-be-discovered mechanism is likely to complement to or substitute for Bjork's set differentiation and differential rehearsal hypothesis.

Though the literature does contain contradictory findings with regard to aging, victims of abuse, and other exceptional human experiences, directed forgetting is a quite robust phenomenon under a variety of normal conditions. As a consequence, the bulk of research on directed forgetting has focused on eliciting the effect from individuals who would not be considered unusual exceptions to the normal population.

Methods of Elicitation

Explicit Tests

Numerous methodological variations exist in the literature for capturing the response to the instruction to forget. Though many elicitation procedures are used to assess the success of the directed forgetting exercise, each of the tests falls into one of two categories—an implicit test or an explicit test—when the critical underlying aspects of elicitation are correctly considered. That is, while the tests often appear much the same on the surface, the difference lies in whether or not the measures reflect conscious recollection of a prior event. As Roediger (1990) explains, explicit tests "reflect conscious recollections of the past" (p. 1043). Per this definition, Johnson & Hasher (1987) classify free recall, cued recall, and recognition as explicit or direct tests of memory. Despite other tests employed, free recall is an inherently different type of memory test because it provides no probe for elicitation of the words to be remembered and thus represents a purely conscious search (i.e., explicit test) and retrieval of a previously stored item. Table 1 presents a representative list of studies from the past 40 years which have employed explicit tests of memory.

Implicit Tests

In stark contrast to explicit tests of memory, "implicit tests of retention measure transfer (or priming) from past experience on tasks that do not require conscious recollection of recent experiences for their performance" (Roediger, 1990, p, 1043). While implicit tests take a variety of forms, the most common include (1) lexical decision, (2) word identification, and (3) stem or fragment completion (Schacter, 1987).

Notwithstanding the prevalence of these types of tests, Johnson & Hasher (1987) also identify homophone spelling, perceptual identification tasks, word completion, and skill learning as other useful indirect or implicit memory tasks. Table 2 presents a representative list of studies from the past 40 years which have employed explicit tests of memory.

Use of Probes

One should carefully note that explicit and implicit tests are often categorized on the basis of whether or not a probe (semantic, lexical, or visual) is used to elicit memory. The distinction then becomes one of cued recall versus free recall, with the cued recall items representing either an explicit test (i.e., word recognition) or an implicit test (i.e., lexical decision[4], word identification[5], stem[6] or fragment completion[7]). Frequently encountered implicit tests include (1) cued recall by word or non-word paired associates, (2) cued recall with stem completion, and (3) cued recall with fragment completion.

List Method

In addition to differentiating between explicit and implicit tests, one must also consider the differences between the list and item methods of testing the directed forgetting phenomenon. While the list method was the first method employed to test this phenomenon, the item method has been no less significant in terms of its contribution to

4 Lexical decision tasks require the participant to decide whether or not the letters viewed represent a legitimate word (Schacter, 1987).
5 "Subjects are given a brief exposure (e.g., 30 ms) to a stimulus and then attempt to identify it" (Schacter, 1987, p. 507).
6 Word stems involve forms such as __ __ __ c t i o n (priming for reaction).
7 Word fragments take the form of __ e __ c t __ __ n (priming for reaction).

Table 1: Studies Employing Explicit Memory Tests

AUTHOR	YEAR
McKinney & Woodward	2004
Kimball & Bjork	2002
Fleck, Berch, Shear, & Strakowski	2001
Marks & Dulaney	2001
Oberauer	2001
Suzuki	2001
Williams & Zacks	2001
Paz-Caballero & Menor	1999
McNally, Clancy, Metzger, Lasko, & Pitman	1998
Mulligan	1998
Myers, Brewin & Power	1998
Edwards & Bryan	1997
Fein, McCloskey, & Tomlinson	1997
Kassin & Sommers	1997
Perfect & Dasgupta	1997
Cloitre, Cancienne, Brodsky, Dulit, & Perry	1996
Golding, Roper, & Hauselt	1996
Harnishfeger & Pope	1996
Zacks, Radvansky, & Hasher	1996
Russo & Andrade	1995
Gershberg & Shimamura	1994
Basden, Basden, & Gargano	1993
Roediger, Weldon, Stadler, & Riegler	1992
Paller	1990
Roediger	1990
Coe, Basden, Basden, Fikes, Gargano, & Webb	1989
MacLeod	1989
Einstein & Hunt	1980
Bjork	1970

Table 2: Studies Employing Implicit Tests

AUTHOR	YEAR
Fleck, Berch, Shear, & Strakowski	2001
Suzuki	2001
Paz-Caballero & Menor	1999
Myers, Brewin, & Power	1998
Cloitre, Cancienne, Brodsky, Dulit, & Perry	1996
Gellatly, Parker, Blurton, & Woods	1994
Gershberg & Shimamura	1994
Basden, Basden, & Gargano	1993
Rajaram & Roediger	1993
Roediger, Weldon, Stadler, & Riegler	1992
Paller	1990
Roediger	1990
MacLeod	1989
Einstein & Hunt	1980
Hyde & Jenkins	1973

our understanding of this phenomenon. Table 3 presents a representative listing of studies from the past 40 years which have employed the list method of directed forgetting. The list method of directed forgetting is characterized by (1) presenting an initial list of words which participants are expected to learn, (2) allowing time for practice of each word as it is presented on a computer screen, flash cards, or other mechanism, and (3) presenting the final list of words which participants are then instructed to learn instead of the first list, which is deceptively purported to have been for practice purposes.

Table 3: Studies Employing the List Method

AUTHOR	YEAR
Goernert, Widner, & Otani	2006
Vonk	2006
Marche, Brainerd, Lane, & Loehr	2005
Basden, Basden, & Morales	2003
Kimball & Bjork	2002
Conway, Harris, Noyes, Racsma'ny, & Frankish	2000
Myers, Brewin & Power	1998
Whetstone & Cross	1998
Harnishfeger & Pope	1996
Basden, Basden, & Gargano	1993
Coe, Basden, Basden, Fikes, Gargano, & Webb	1989
Einstein & Hunt	1980
Wilson, Horvath, Johnson, Woodward	1975
Bjork & LeGrand	1968

Item Method

The item method differs from the list method in only by procedure. Each word (or item) is presented one at a time (as in the list method), but an instruction to remember or to forget is presented with each item, generally a few seconds after the initial display of the word on the screen. Thus, each word is viewed for a short time, and the participant then is given instructions regarding the requirement to remember or to forget the word. Unlike the list method, therefore, is not an inevitable element of this procedure. Table 4 presents a representative listing of students from the past 40 years which have employed the item method of directed forgetting.

Table 4: Studies Employing the Item Method

AUTHOR	YEAR
Vonk	2006
McKinney & Woodward	2004
Lehman, Srokowski, Hall, Renkey, & Cruz	2003
Fleck, Berch, Hsear, & Strakowski	2001
Marks & Dulaney	2001
McNally, Clancy, & Schacter	2001
Tekcan & Aktürk	2001
Korfine & Hooley	2000
Paz-Caballero & Menor	1999
McNally, Clancy, Metzger, Lasko, & Pitman	1998
Cloitre, Cancienne, Brodsky, Dulit, & Perry	1996
Golding, Roper, & Hauselt	1996
Zacks, Radvansky, & Hasher	1996
Russo & Andrade	1995
Basden, Basden, & Gargano	1993
Paller	1990
MacLeod	1989
Wilkie, McNeill, & Mazis	1984
Geiselman, Bjork, & Fishman	1983

Recollection versus Encoding

It is especially important to observe that conscious recollection is not the same thing as conscious encoding. While this may seem quite intuitive, the distinction can become blurred when examining studies motivated by the desire to capture incidental learning during directed forgetting exercises. Despite the fact that one may employ an explicit test for a memory trace, the participant may have encoded the item deliberately or incidentally. For example, ratings of the pleasantness of words (Hyde & Jenkins, 1973), attributions of self (Myers, Brewin, & Power, 1998), counting occurrences of “e”

or “g” in words (Hyde & Jenkins, 1969; 1973), identification of parts of speech (Hyde & Jenkins, 1973); and sentence frame fitting[8] (Hyde & Jenkins, 1973) all represent implicit memory tasks when the subsequent recall or recognition task requires the participant to provide one or more words used in the task rather than the pleasantness, relation to self, number of “e's” or “g's,” part of speech, or suitability for use in a particular sentence of the words used in the task.

Explanations

Though directed forgetting had originally been conceptualized and operationalized using an explicit test of memory (and many explicit test variations were quickly developed), researchers soon turned to a comparison of the results using explicit and implicit measures. Presumably this interest in implicit memory and the directed forgetting effect was fueled not only by a desire to “solve” the differential rehearsal debate, but interest increased as a direct result of the additional attention that implicit memory was receiving at the time in other arenas.[9] MacLeod’s (1989) demonstration of directed forgetting effects in both direct and indirect tests of memory seemingly caused researchers to double their efforts in seeking an explanation for the directed forgetting effect. As a consequence, countless studies have examined the directed forgetting phenomenon using and endless variety of implicit and explicit tests.

Impetus for Change

As a result of Johnson and Hasher’s (1987) identification of the need to explain

8 Sentence frame requires participants to complete sentences such as “It is _____.” or “It is a ____.” with nouns or adjectives that structurally will only fit in one or neither of the constructions. (See Hyde & Jenkins, 1973, for a more complete description.

9 See Schacter, 1987, for a review of these issues.

directed forgetting in a variety of memory tasks, MacLeod (1989) constructed experiments to elicit the directed forgetting effect in both explicit and implicit tasks. His results were successful. Subjects in his experiments demonstrated the directed forgetting effect (1) in the direct tests by recognizing and recalling more to-be-remembered words than to-be-forgotten words and (2) in the indirect tests by completing more to-be-remembered word fragments and responding more rapidly to to-be-remembered words in a lexical decision task[10] . These effects were attributed to a retrieval inhibition phenomenon recently demonstrated (albeit unreliably) by Geiselman et al. (1983) and Geiselman & Bagheri (1985). This new explanation for the directed forgetting effect became the impetus which shifted the research focus from effect to methodology.

Problems on the Horizon

Studies in the late 80's and 90's which focused on the methodologies used to demonstrate the directed forgetting effect concentrated primarily on one of two issues: (1) type of test—explicit or implicit or (2) presentation of material—list versus item. Though many studies have been published, two studies in particular clearly demonstrate this focus: Paller (1990) and MacLeod (1989). Paller's (1990) study represents a unique comparison of recall and stem-completing priming by employing EEG results to demonstrate the differences in mental activity during cued recall and free recall during a directed forgetting task. This research is particularly important in that it clearly identified a problem in unilaterally accepting MacLeod's (1989) articulation of the retrieval inhibition mechanism. MacLeod (1989) asserted that "retrieval manipulations, unlike

10 A lexical decision task measures the latency of response to a cue presented on a computer screen. Thus, it is a "recognition" task with a different measure of positive response—reaction time.

elaboration manipulations at encoding, affect[ed] direct and indirect tests in similar ways." p. 13.) Specifically, Paller's results demonstrated (on a physical basis) that retrieval inhibition could not explain the "differential effects of directed forgetting on two tests that differed only in the nature of their instructions" (Paller, 1990, p. 1027). He noted, however, that one might reconcile the results of his experiments with MacLeod's assertions if the form of the presentation of the stimuli were considered. While his experiments had presented the stimuli and the direction to forget simultaneously, most other studies involved presenting a direction to forget either before or after subjects viewed an initial list of words. In his experiments, the instruction to forget was indicated at time of word presentation by word color. Thus, either timing of the instruction to forget was critical to the directed forgetting effect or direct (explicit) or indirect (implicit) tests were affected differently by instructions to forget. This assertion, as it soon was observed, proved to be critical to future research. Other researchers soon began to question the effects observed for explicit versus implicit tests as well as different forms of implicit tests.

Differing Effects

The collective wisdom emerging from studies such as MacLeod (1989), Paller (1990), and Basden, Basden, & Gargano (1993) established that all tests did not elicit the same phenomena. The list method and the item method, for example, clearly produced differential results, and these differential results required different explanatory hypotheses. Specifically, Basden, Basden, & Gargano (1993) concluded that the list method of directed forgetting was better explained by retrieval inhibition while the item-

by-item method was better explained by differential encoding. Furthermore, these researchers interpreted the experimental results obtained in terms of two larger theoretical frameworks: distinctive-relational processing theory and (revised) generation-recognition theory. Adopting Transfer Appropriate Protocol [TAP] theory (initially posited by Roediger (1990) and Roediger, Weldon, & Challis (1989) as a complementary explanatory theory for the directed forgetting effect), Basden, Basden, & Gargano (1993) significantly broadened the foundation upon which subsequent interpretations of the directed forgetting phenomenon would be made. They articulated the theoretical rationale for different interpretations of list-method and item-method directed forgetting. In particular, they explained that data-driven processes such as reading words should show direct effects in data-driven tests (e.g., fragment completion) while conceptually driven processes such as the generation of words should show direct effects in conceptually driven tests (e.g., free recall). Thus, they paved the way for their subsequent assertion that distinctive-relational processing was an adequate explanation of the reasons for differential effects observed in list-method and item-method tests of differential forgetting. While list-method studying encourages relational processing of items, item-method study encourages distinctive processing. This dichotomy seems to offer itself as a natural addition to Bjork's (1970) assertion that differential rehearsal could only be a partial explanation of the directed forgetting effect.

New Hypothetical Mechanisms

Thus, part of the cause for differential effects on directed forgetting manipulations on implicit and explicit tests of memory could be explained by the operation of two

different mechanisms. Furthermore, Jacoby and Hollingshead's (1990) revised generation-recognition theory provided the other (though not necessarily final) piece of the puzzle. In their conceptualization of the distinction between direct and indirect tests of memory, explicit tests are assumed to involve both generation and recognition, but implicit tests are assumed to involve only generation (Jacoby & Hollingshead, 1990). Thus, a second part of the explanation for the differential effects seen on explicit versus implicit tests of memory could be attributed to the nature of the test itself. Thus, Bjork's assertion that the directed forgetting effect was only partially explicable by differential encoding was apparently correct. It only took 40 years for research to provide an adequate explanation for the effects.

Other Research Directions

Despite the fact that all issues surrounding directed forgetting might seem resolved, research on the directed forgetting effect continues to date. Numerous studies have emerged in recent years which have opened new arenas for investigation. Advances in medical technologies are becoming increasingly important to the research paradigm. Measurement of event-related brain potentials [ERP's] are beginning to reveal that different parts of the brain are activated during recall and recognition (Davachi, Mitchell, & Wagner, 2003) as well as free recall and cued recall but not for stem completion (Paller, 1990). Furthermore, similarities between responses of amnesic patients to memories for new associations shows promise in aiding understanding the directed forgetting phenomenon (e.g., Shimamura, Salmon, Squire, & Butters, 1987; Shimamura, 1986). Thus, the tendency or lack of tendency for individuals with special cognitive

abilities to exhibit the directed forgetting effect is providing insight into what appears at times to be an elusive phenomenon.

While children were probably the first special group to be investigated for the directed forgetting effect, special adult populations soon followed. Recent studies have demonstrated rather strikingly that differential rehearsal is a better explanation of the directed forgetting effect for children than is retrieval inhibition (Lehman, McKinley-Pace, Leonard, Thompson, & Johns, 2001). Conversely, the effect exhibited by adults (i.e., a greater tendency to recall to-be-forgotten words) in comparison to children suggests that a retrieval inhibition hypothesis with age limitations might better explain the effect for older adults (Zacks, Hasher, & Radvansky, 1996). Other areas of recent interest include: retrieval inhibition and closed head injury (Schmitter-Edgecombe, Wright, Marks, & Ventura, 2004), posttraumatic stress disorder (Zellner, Foa, & Sachs, 2003), acute stress disorder (Moulds & Bryan, 2002), sexual abuse (McNally, Clancy, & Schacter, 2001; McNally, Clancy, Lasko, & Pitman, 1996), as well as incidental learning and a two-factor theory (Sahakyan & Delaney, 2005).

It is therefore clear that this field of research is not extinct. In fact, with the recent introduction of medical techniques of investigation into the field (EEG, fMRI, etc.), it is likely that this field will continue to attract researcher who are captivated by an individual's inability to follow a simple instruction: "forget…"

Summary

Despite the fact that the literature on directed forgetting covers nearly 40 years, the literature is nearly silent on the effects of color or typeface on the ability of an

individual to forget information previously viewed. Moreover, this literature does not consider the potential effects of perceptual mechanisms which are relatively uncontrollable by the observer. This review of literature has identified several important findings with regard to directed forgetting research. First, the phenomenon has been observed in numerous studies of human behavior using numerous elicitation techniques, including both explicit and implicit tests of the phenomenon. Second, despite the fact that the results obtained often differ between the two methods, the directed forgetting effect has been observed under both the list method and item method. Further, the effects are robust under both explicit and implicit tests of memory. Third, a careful distinction must be drawn between tests involving recollection versus recall. Each involves a potentially different explanatory mechanism for the directed forgetting effect, and each has, in fact, been shown to activate different parts of the brain. Fourth, prior research makes it clear that one explanatory hypothesis is insufficient to capture the differing effects of the list and items methods of elicitation. This conclusion has been further substantiated by results obtained through examination of aging patients and those with amnesia. Finally, though less important to this research, the directed forgetting effect has been observed in tests of pigeons and rats, thereby suggesting that its effect exists in parts of the animal kingdom other than humans. While this literature makes it clear that individuals cannot simply forget previously viewed items on command, it does not clarify which, if any, attributes of the viewed materials are potentially responsible for the inability to forget those items.

Chapter 3

METHODOLOGY

This chapter explains the methods used to complete this research. The following pages describe the (1) participants in this research, (2) the research design, (3) the independent variables, (4) the dependent variable, and (5) the procedures employed.

Participants

The 184 participants in this research were students enrolled in a small Midwestern university who volunteered to participate in the research. They were invited to participate through direct email requests sent to the entire student body as well as through (1) announcements of the research project made by faculty members in the schools of business, arts and sciences, and music and (2) posted notices of the research project across campus. Participation was entirely voluntary, and participants were allowed to withdraw from the project at any point if they changed their minds concerning their willingness to participate. Each of the 184 participants completed the entire task.

Design

This study consisted of two randomized factorial ANOVAs with two independent variables and a single dependent variable. Each of the two independent variables consisted of two treatment levels. These variables and their corresponding levels are listed as follows: (1) color of font: red versus blue; and (2) font type: Arial versus Times New Roman.

Independent Variables

The color variable was manipulated by varying the color of the font in which each word or list of words is presented to the participants. The two colors selected for this search were red and blue. These colors were selected based on their frequent appearance

in formal presentations. Participants were randomly assigned a red or a blue font condition.

The font variable was manipulated by varying the typeface in which each word or list of words was presented. The two fonts selected for this research were ARIAL and TIMES NEW ROMAN. These fonts were selected because of their predominance in printed materials and because one represents a distinctively sans serif font (Arial) while the other represents a serif font (Times New Roman). Participants were randomly assigned to the Arial or Times New Roman typeface condition.

Dependent Variable

The dependent variable was the number of correct words identified by each participant in the memory task to which he/she was assigned—recall or recognition. Whether a function of recall or recognition, the number of words previously viewed which an individual has been instructed to remember constituted the criterion of interest. Though not of primary concern, the number of to-be-forgotten words recalled or recognized by a participant (called intrusions) might be an important indication that either font or typeface represents a perceptual effect that cannot be overcome by mere instruction.

Procedures

The stimuli for this study were presented to the participants in computerized form. The computer program used to present the stimuli first randomly assigned each participant to one of the two ANOVAs—List versus Item. These two ANOVAs differed in terms of presentation type (List and Item) and test type (Recall versus Recognition).

While at least three different presentations of the task have been used in prior research1[11], these two presentation types were chosen because of their predominance in the literature and the differential effects often found for the these two presentation modes. Additionally, nearly all investigations of the directed forgetting phenomenon use one of two task types—Recognition or Recall—because they are believed to engage different cognitive mechanisms. Nonetheless, because the recognition task contains distractor cues while the recall task does not contain such cues, it is impossible to construct a single completely randomized ANOVA that would be free of confounded results for these procedures. Therefore, participants randomly assigned to the list condition were presented only the recall task. Participants randomly assigned to the item condition were presented only with the recognition task (which included distractor cues).

Because the presentation of the words and the subsequent tests of memory were timed events, the process of data collection, once begun, required no interaction with the researcher after an initial explanation of the procedures. (Only one participant had difficulty in understanding that the return key had to be pressed between each word to record the words recalled. This was quickly resolved, and the test continued without significant interruption.) The computer program recorded the words typed by each participant in the recall task, and it recorded the words identified as recognized (by mouse click) in the recognition task.

List Method

Participants assigned to the list condition were presented with the following

11 The simultaneous approach presents all stimuli at one time and requests that the participant ignore one of the stimuli.

instruction on the screen: "Try to remember as many of the words in the upcoming list as you can. Each word will be presented only briefly, but you should try to remember as many as possible. When you are ready to begin, depress the space bar." Upon depressing the space bar, the presentation of the first list of 15 words, the TBF words, began. Each word was presented in uppercase letters in the center of the screen on a light gray background for six seconds with a two-second interval between each word presented. After presentation of the first list, a 10-second pause occurred before the second instruction—the global forget instruction—was presented. The participants then were presented with the following instruction on the screen: "Forget all the words in that list. They were for practice. Instead, try to remember as many of the words in the upcoming list as you can. Each word will be presented only briefly, but you should try to remember as many words as possible." The second set of 15 words, the TBR words, was then displayed for the same lengths of time as in the first list.

Upon completion of the two list administrations, participants were asked to perform a brief distractor task. This task consisted of selecting the state capital (of a randomly selected state) from a list of 4 prominent cities and a "none of the above" choice. The distractor task continued for 30 seconds regardless of the number of correct or incorrect responses generated by the participant. It was immediately followed by a recall or a recognition test.

Item Method

Participants were presented with the following instruction on the screen: "On each of the upcoming screens, you will be presented with a word for six seconds. During

the last two seconds of its display, you will be told whether you should attempt to remember the word or forget the word by the word “remember” or “forget” which will appear beneath the word on the screen. Try to remember as many words as possible that you are instructed to remember. When you are ready to begin, depress the space bar.” Upon depressing the space bar, the presentation of the 30 words began. Each word was then presented in uppercase letters in the center of the screen on a light gray background for six seconds with a two-second interval between each word presented. As previously noted, fifteen of the words were joined by a “remember” instruction while 15 of the words were joined by a “forget” instruction during the last second of the display. The “remember” and “forget” instructions were randomly generated to avoid possible patterned responses which would corrupt the results.

As in the list method portion of the experiment, the same state capital distractor task filled 30 seconds between the viewing of the 30th word in the list and the beginning of the data collection phase.

Recall Test

Upon presentation of the final stimuli and completion of the distractor task, the computer program automatically advanced to the data collection stage, either a recall or recognition task. Participants in the list presentation mode were then presented with the recall task condition which instructed them to type as many words as they could remember from the TBR words previously viewed (an explicit test of memory). This phase of the test continued until 30 seconds had lapsed since the last keyed response. The keyed responses were stored by the program in a database along with the list viewed and

the particular font and color characteristics of the words viewed.

Recognition Test

For those participants randomly assigned to the item presentation mode, the computer program automatically advanced to the word recognition phase of the experiment after the distractor task has ended. During this task, a cued recall probe of memory (also an explicit memory test), participants were given instructions on the screen that they were to identify as quickly as possible from among the words appearing on the upcoming screens those words which they had previously been instructed to remember. Specifically, they viewed the following on-screen instruction: "On the upcoming screens are words to which you are to respond "yes" or "no." If the word is from the words you were instructed to remember, please click on the "YES" button as quickly as possible. Otherwise, click on the "NO" button and continue. Be as accurate as possible, but proceed as rapidly as seems appropriate. You will not be permitted to return to a previous screen should you change your mind." Each word appeared for as long as it took the respondent to click on either the appropriately titled "YES" or "NO" box appearing on the screen.

Demographic Data

The final phase of data collection requested on-screen responses to the following items: (1) major, (2) classification in college, (3) age, (4) approximate number of hours per day spent reading, (5) preference for the color of one word presented in 2 different colors (red and blue), and (6) preference for font style (serif, sans serif) of one word presented in 2 different font faces (Times New Roman and Arial). Some of these

demographics were used to describe the specific characteristics of the sample.

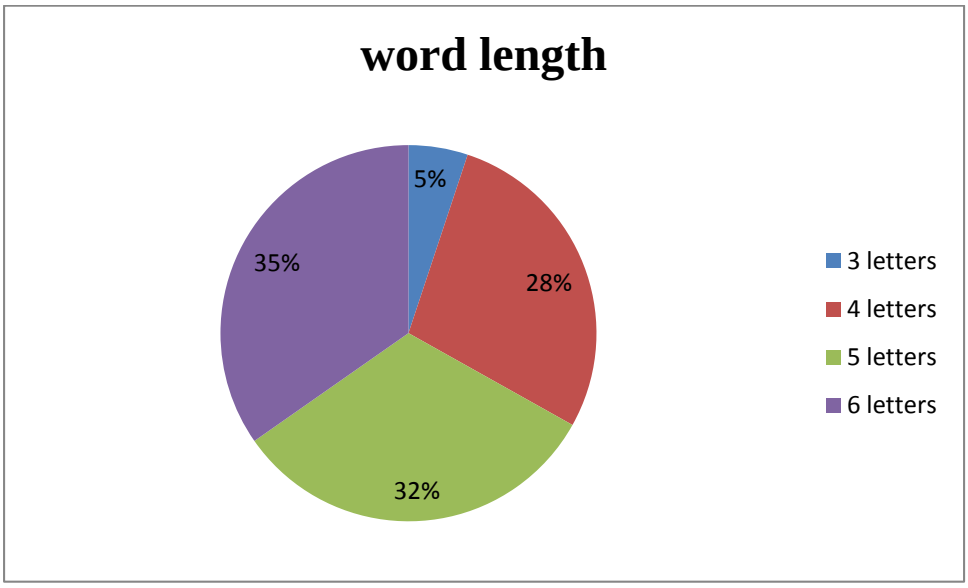
CHAPTER IV

RESULTS

This chapter is a presentation of the results of the analysis of data collected from 184 participants in a study of the effects of color and typeface on two methods of directed forgetting. The following pages describe (1) the research design employed in each method of directed forgetting, (2) the analyses performed, (3) the significance of the results, and (4) a summary of the findings.

The analysis of data was designed to determine whether the instruction to forget words which participants had previously viewed on a computer screen was influenced by the color of the words presented or the typeface in which those words were presented. Random word lists were created from a psycholinguistic words database (available online) which represented 314 words selected from nouns of three to six letters in length which were no more than two standard deviations from average word difficulty or familiarity as determined by scores of (1) familiarity, (2) concreteness, (3) imageability, and (4) meaningfulness on the a combination of scales included in the psycholinguistic database. A variety of words were deliberately excluded from the inclusion in this project's database of words because their peculiar nature might make them more memorable than the words selected and thus bias the results. Because some words by their very nature could be more memorable, words presented to participants excluded specialized, archaic, capital, dialect, nonsense, foreign/alien, rhetorical, erroneous, obsolete, poetical colloquial, rare, plurals, nonce words, derivatives of other words in the database, and those ending in silent “r”. Figure 1 represents the distribution of the 314 words used in the database from which the randomized lists of words were chosen for presentation to participants.

Figure 1: Distribution of Word Length



Preliminary analysis of the data began with extracting the data from the computer program from which they were collected and verifying that (1) no participants provided data incompatible with the analysis (e.g., numbers provided instead of words during the recall test), (2) no data sets had missing values, and (3) total correct responses plus total errors were equal for all participants in the same test conditions. All participants provided data compatible with the analysis to be conducted, no data sets had missing values, and responses summed to the correct total for each test type (thus verifying that the computer program had not incorrectly recorded any response).

With a total of 184 participants, the distribution of participants between the list method and the item method was fairly close to equal across the item and list methodologies. As table 5 shows, 89 participants were randomly assigned to and completed the list method of directed forgetting while a total of 95 participants were randomly assigned to and complete the item method of the directed forgetting. Further,

one can see that the number of participants per cell was sufficient to assume normality of the distribution across the experimental conditions.

Table 5: Participants per Cell and in Total

	RECALL		RECOG			
	BLUE	RED	BLUE	RED	TOTAL	
ITEM Method						
ARIAL	0	0	24	13	37	*89*
TIMES	0	0	30	22	52	
LIST Method						
ARIAL	23	26	0	0	49	*95*
TIMES	22	24	0	0	46	
	45	50	54	35	184	
	95		*89*			

As depicted in table 5, participants were randomly assigned to either the list or item method groups. Then, they were randomly assigned to the four treatment combinations. Participants were not, however, randomly assigned to the recall versus the recognition tests because of inherent differences in presentation of the item and list methods that make results of recall versus recognition tests incomparable. To have randomized across these two conditions would have confounded the results. While both the item and list methods included an equal number of words to be remembered or forgotten, the elicitation of responses during the testing phase were not comparable. Thus, the item method was paired with the recognition test. The recognition test included 15 previously viewed words to be remembered, 15 previously viewed words to be forgotten, and 15 **distractor** words which had *not previously been viewed*. Alternately, the recall test was paired with the list method. During elicitation of responses under the list method, participants were given no cues for the words to be entered. They were expected only to

type the 15 previously viewed words to be remembered and *not* type the15 previously viewed words which they had been instructed to forget. While neither recall nor recognition participants were presented with **distractor** words during the initial presentation of the words, participants in the *recognition* test category were presented with words not previously viewed. Stated differently, one cannot be presented a word if he or she is asked only to recall the words previously viewed and instructed to remember. Thus, the results of the recall test and the item test are not directly comparable.

The Item-Recognition Method

The analysis of data collected under the item-recognition method was guided by the question of whether or not a significant interaction existed for color and font type with total correct responses. Descriptive statistics for participants in the item recognition method are shown in Table 6.

Table 6: Descriptive Statistics—Item-Recognition Method

ITEM METHOD

Descriptive Statistics

Dependent Variable: Total Correct Responses

Font	Color	Mean	Std. Deviation	N
Arial	Blue	40.8333	3.42201	24
	Red	38.5385	4.96010	13
	Total	40.0270	4.11290	37
Times New Roman	Blue	37.9333	4.89851	30
	Red	40.4091	4.05509	22
	Total	38.9808	4.68410	52

Statistical analysis of the responses of participants in the item method condition revealed a significant interaction between font and color (F=6.104, df=1, p=.015). The ANOVA

summary results for participants in the item method are given in Table 7.

Table 7: Item-Recognition Method ANOVA Results

Tests of Between-Subjects Effects

Dependent Variable: Total Correct Responses

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Font	5.368	1	5.368	.284	.595	.003
Color	.166	1	0.166	.009	.926	.000
Font * Color	115.306	1	115.306	6.104 *	.015	.067
Error	1605.749	85	(18.891)			
Total	1751.618	88				

The value in parentheses represents the mean square error.

* p < .05

Because the interaction of font and color for total correct responses was significant, a test of simple main effects was performed to reveal the nature of the interaction. Table 8 presents the test of simple main effects. The results indicate that the color blue resulted in a statistically significant effect across the two font types (F=5.935, df=1, p=.017) whereas the color red was not significant across font types (F=1.514, df = 1, p=.222). This significant effect was associated with a partial eta squared of .07, which is a moderate effect.

Table 8: Univariate Test of Total Correct Responses

Dependent Variable: Total Correct Responses

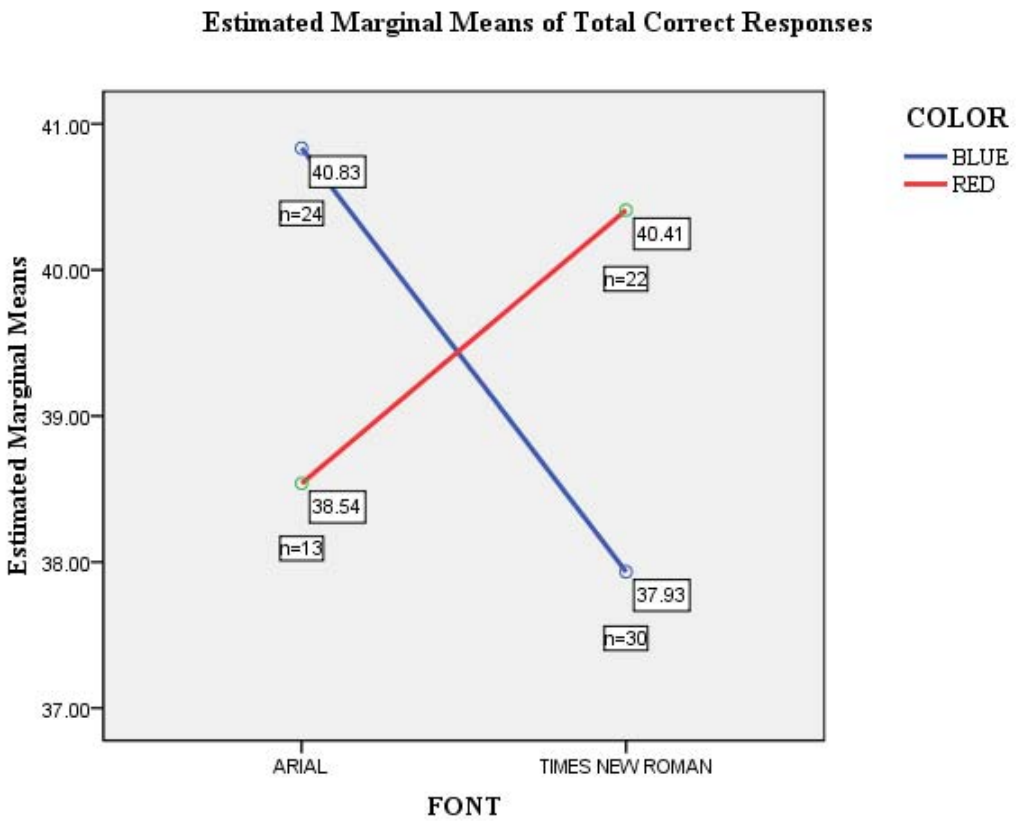
Color		Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Blue	Contrast	112.13	1	112.13	5.936	0.017	0.07
	Error	1,605.75	85	18.89			
Red	Contrast	28.59	1	28.59	1.514	0.222	0.02
	Error	1,605.75	85	18.89			

Each F tests the simple effects of font within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = .05

Figure 2 graphs the disordinal interaction that existed between font and color for the total correct responses of participants in the item condition.

Figure 2. Disordinal Interaction of Font and Color with Correct Responses



The List-Recall Method

The analysis of data collected under the list method of presentation and recall method of testing was guided by the question of whether or not a significant interaction existed for color, font type, presentation mode and total correct responses to a recall test. Descriptive statistics for participants in the item condition are shown in Table 9.

Table 9: Descriptive Statistics—List-Recall Method

LIST METHOD
Descriptive Statistics
Dependent Variable: Total Correct Responses

Font	Color	Mean	Std. Deviation	N
Arial	Blue	20.3913	2.95018	23
	Red	20.1923	4.57838	26
	Total	20.2857	3.86221	49
Times New Roman	Blue	22.2727	3.34068	22
	Red	20.8333	3.65545	24
	Total	21.5217	3.54488	46

Statistical analysis of the responses of participants in the list method condition identified a nonsignificant interaction between font and color (F=.659, df=1, p=.419). Additionally neither main effect was found to be statistically significant. The ANOVA summary results for participants in the item method are given in Table 10.

Table 10: List-Recall Method ANOVA Results

Tests of Between- Subjects Effects
Dependent Variable: Total Correct Responses

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Font	37.636	1	37.636	2.724	.102	.029
Color	15.878	1	15.878	1.149	.287	.012
Font * Color	9.101	1	9.101	.659	.419	.007
Error	1,257.214	91	(13.816)			
Total	1,317.726	94				

The value in parentheses represents the mean square error.

Summary of Results

This chapter presented the results of analyses performed on data collected from 184 participants in two tests of directed forgetting. The tests were designed to determine whether a direction to forget words previously viewed on a computer screen was affected by the color in which those words were presented or the typeface in which those words

were presented. The random word lists presented to participants in the study consisted of nouns from three to six letters in length selected from a psycholinguistic database. The nouns selected were of based on their degrees of familiarity, concreteness, imageability, and meaningfulness as evinced by scores reported in the psycholinguistic database. The 314 words chosen for use in the study were within two standard deviations from average word difficulty or familiarity and excluded several types of words which would by their very nature be more or less memorable than the words chosen (e.g., nonsense words).

Analysis of the data collected from the 89 participants in the item-recognition task condition revealed a significant disordinal interaction between the fonts—Arial and Times New Roman—and the colors—red and blue ($F=6.104$, $df=1$, $p=.015$). Further analysis of the simple main effects revealed that the color blue resulted in a statistically significant effect across the two fonts Arial and Times New Roman. Alternately, analysis of the data obtained from the 95 participants in the list-recall method of presentation revealed a nonsignificant interaction between color and typeface ($F=.659$, $df=1$, $p=.419$).

CHAPTER V

DISCUSSION AND CONCLUSIONS

The purpose of this chapter is to present a discussion of the results obtained through analysis of the data, the possible implications of those results, recommendations for future research, limitations of the study, and conclusions drawn from the study.

Discussion of Results

As identified in Chapter 4, analysis of data collected from 89 participants randomly assigned to the item method of presentation coupled with the recognition method of testing revealed a significant disordinal interaction ($F=6.104$, $df=1$, $p=.015$) between font and color for items correctly remembered. Analysis of the simple main effects, however, revealed that the color blue resulted in a statistically significant effect across the two fonts Arial and Times New Roman, but the color red resulted in a nonsignificant effect. Further, a significant interaction was not identified by the analysis of data collected from the 95 participants randomly assigned to the list method of presentation coupled with the recall testing method ($F=.659$, $df=1$, $p=.419$).

While it was not surprising that participants could be successfully instructed to forget words they have previously viewed, the fact that a significant disordinal interaction for font and color was identified for participants in the item/recall condition but not the list/recognition condition was an outcome not initially expected. From casual comments obtained from participants as they left the experimental session, at least one possible explanation of the different results can be identified. Many participants who viewed the words to be remembered in the list format commented that they simply encoded the words in a story that they created as they viewed the words. This story might have enabled deeper encoding and thus facilitated recall during the testing phase of the

experiment. Furthermore, focusing on the encoding through creation of a story possibly required less attention be paid to the color or typeface in which the words being encoded were presented. Alternately, participants in the item condition did not frequently volunteer the fact that they had used a story-telling technique to remember the words they were instructed to remember. Though they might also have used such a technique, employing such a technique would have been complicated by the fact the participant had to pay closer attention to each word until the remember or forget instruction was presented on the screen. Such was not the case for the list method participants. List method participants believed that each word in an entire list of words was to be remembered until they were told to forget one of the lists. Therefore, though a story could be created for the words eventually to be forgotten, the story could also more easily be disregarded as a whole when participants were given the instruction to forget that group of words. Stated differently, the task of remembering or forgetting words as a group may focus more on the whole process of connecting the group of words through a story than it depends on distinguishing one word from the next word. Remembering or forgetting words with individualized instructions to remember or forget each word at the time of presentation may not lend itself to focusing on the word only.

It may be that the typeface and color of the font become more salient when each word must be individually discriminated from the previously viewed word. Particularly this appeared to be true when the font was blue given that simple main effects tests revealed a partial eta squared of .07 ($F=5.94, df=1, p=.015$) which is generally considered to be a moderate effect. The fact that the color red did not result in a significant effect

might initially be perceived as somewhat surprising given that the color red is generally used in a variety of contexts as a color demanding immediate attention. Consider, for example, the use of red stop signs and stop lights, red flashing lights indicating danger, and even the use of red lettering on other posted signs indicating “danger,” “keep out,” “caution, wet floor,” or even something as simple as “exit.” However, when one considers the fact that the color red has so many common-place uses in everyday life, it may be that the red font was not salient when combined with the two typefaces chosen for this study. If this was the case, font alone—Arial versus times new roman—apparently was not a strong enough cue to elicit significantly different attention to be paid to it during encoding when the font was red.

Though any directed forgetting task may at first seem to be a somewhat artificial task in which to engage, it is nonetheless encountered in real-life situations more than one may initially be aware. For example, in something as simple as remembering that the speed limit has changed on a section of road, one is explicitly being directed to forget the old speed limit and remember the new one. Even more persuasive evidence of the non-artificial nature of directed forgetting can be found in court room trials. Jurors are frequently asked to disregard specific information encountered in the courtroom proceedings, and they often find this nearly an impossible goal to achieve (Edwards & Bryan; 1997; Kassin & Sommers, 1997). Even participants in mock trials exhibit the same tendency to disregard such instructions (Thompson, Fong, and Rosenhan, 1981). Pretrial information has also been shown to exhibit a similar pervasive effect on one's ability to disregard information previously encountered (Fein, McCloskey, & Tomlinson,

1997).

In studying materials in a textbook, one is often presented with simple conceptualizations of difficult ideas, mathematical or theoretical, which later are later dismissed as insufficient explanations of the phenomena under investigation. Thus, one is essentially directed to forget or at least augment a previously encountered explanation and remember a more robust explication of the phenomena. As a consequence, the color and font of presentations may have an impact on one's ability to integrate the new information into his or her memory.

Once again, it would appear that item-by-item instructions to attend to or disregard a particular instruction would appear to present a more significant need to attend to individually discriminating elements present in each item. Alternately, presenting an entire scenario initially to be remembered and subsequently forgotten would seem to lend itself to concentrating on group characteristics rather than individual characteristics of the items being presented as a group. Despite whether participants actually forgot the words they were instructed to forget or simply suppressed these words during elicitation of results, it appears clear that the differing color and typeface of the presentations had some bearing on a participant's ability to respond correctly to cues for words they had been instructed to remember.

Though not examined in this study, implicit tests of directed forgetting might yield different results from those found in this study. Implicit tests, by nature, rely on the priming of a past experience to evoke a memory rather than the conscious recollection of a memory (Roediger, 1990). While this study found a significant interaction for font and

color in measuring successful forgetting in the item and recognition condition, no such result was obtained under the list and recall condition. This at least raises the question of whether font and color become more or less important when implicit tests of memory are employed. Word fragment tests—implicit tests of memory—have have demonstrated effective directed forgetting results (e.g., Tulving, Schacter, & Stark, 1982; Russ & Andrade, 1995; Macrae & MacLeod, 1999; Suzuki, 2001; McKinney & Woodward, 2004) as have stem completion tasks, which are also implicit tests of memory. (See, for example, Schacter & Graf, 1989; Paller, 1990; Gellatly, Parke Parker, Blurton, & Woods, 1994). Despite the fact that Rajaram and Roediger (1993) found that typeface did not affect priming for a stem completion task, their study did not explore the potential interaction between font and color in this implicit task. If color were added as a variable in a stem completion task, for example, the results obtained might be different and might be worthy of further investigation.

Research has recently revealed that different parts of the brain are activated during recall and recognition tests (Davachi, Mitchell, & Wagner, 2003). Research has demonstrated, however, that stem completion tests do not activate different parts of the brain from other tests (Paller, 1990). Therefore, one might question whether free recall and cued recognition depend on different memory traces stored by different mechanisms in different parts of the brain. One might naturally conclude that cued recall is ostensibly an easier method of eliciting responses from memory than is free recall. However, this conclusion might be altered if one were to explore the role that visual stimuli play in moderating the storage process itself. Then, the answer to whether or not visual priming

plays a more or less significant role in implicit tests of directed forgetting becomes less clear. In a study of priming of memory for objects, Hupbach, Melzer, and Hardt (2006) concluded that color mediated the perceptual priming process. When the results obtained in this research on directed forgetting are considered in light of Hupbach, Mulzer and Hardt's (2006) findings, one might question further exactly which aspects of the perceptual priming cues are primary or secondary mechanisms which influence the ability to forget in implicit as well as explicit free recall and cued recall tests. Moreover, one is lead to question whether or not uppercase versus lowercase letters lead to visually distinctive processing which have differential impacts on directed forgetting.

While this study used only common nouns with a relatively high degree of familiarity, no explicitly emotionally laden words were used. This selection of non-emotionally laded words and their randomization should have effectively limited the possible effect of an emotional response to the words having played a role in the outcomes obtained. This is important because it has already been demonstrated that information becomes increasingly more difficult to forget as that information becomes emotionally laden ((Edwards & Bryan, 1997). While yet untested, it might be worth exploring whether color and typeface might become more or less salient cues for recognition if the words viewed were chosen from a group of emotionally laden words.

Implications

The results of this study have direct implications on the manner in which written stimulus materials are presented on which readers are directed to focus. Whereas the primary goal of directed forgetting studies has traditionally been to obtain significant

performance results in both the list and item methods of directed forgetting (i.e., the participants successfully forgot the words they were directed to forget) as well as provide theoretical explanations for differences in the outcomes of implicit and explicit tests, the results obtained in this study appear to indicate that differences in presentation mode may have important implications for the method of encoding used by participants when viewing the words presented. Though the results obtained in this explicit test of directed forgetting demonstrated a significant interaction between color and font for successful forgetting of words presented in the item method but not the list method, these results add significances to Basden, Basden, & Gargano (1993) assertion that distinctive-relational processing was a more robust explication for differential effects observed in list-method and item-method tests of differential forgetting. While Bjork (1970) had asserted that differential rehearsal could only be a partial explanation of the directed forgetting effect, Basden, Basden, & Gargano (1993) complemented this theoretical explanation of differing results by suggesting that the list-method of studying favors relational processing of items while the item-method study encourages distinctive processing. These theoretical explanations are consistent with the results obtained in this study. Moreover, this distinction appears to coincide with comments frequently made by participants as they were leaving the study. This informal observation leads one to believe that differential rehearsal played a greater part in the list method of directed forgetting, but it cannot be assumed that it played no role in the item method since all participants were not specifically asked what memory device they used to achieve their results. However, the fact that the item method of presentation resulted in an interaction

between color and font does lead one directly to the conclusion that distinctive processing played a role in successful forgetting of words viewed. This indicates that the entire process as initially asserted by Bjork (1970) is more than an effect of differential rehearsal, and it leads one to believe that perceptual cues of font and color may play a larger role in the ability to remember or forget than one might have previously suspected.

When one recalls that the two methods of elicitation used in this study—free recall and recognition—are explicit or direct tests of memory (Johnson & Hasher, 1987), one is led to question whether the mode of presentation (i.e., perceptual cues) might play an increasingly important role in performance when various implicit tests of memory are employed. The results of this study suggest that the directed forgetting phenomenon is at least partially a perceptual issue and not limited to the suppression of cues or simply differential rehearsal of items viewed in the item method.

Though one might initially conclude that the ultimate test of memory for an item is the free recall of that item without any type of cue, cued recall nonetheless occupies a significant place in tests of memory and cannot be dismissed without further examination. Notwithstanding the fact that free recall is an obvious, frequently encountered explicit test of memory, one cannot dismiss implicit tests of memory as artifacts of psychological research. Though conscious evaluation of one's prior experience is not inherently an integral part of implicit tests of memory (Roediger, 1990), these types of tests are nonetheless routinely encountered just as explicit are encountered on a daily basis.

Although the explicit tests of memory as constructed in this study might appear to

represent somewhat artificial experiences because individuals are infrequently required simply to recall words presented on a computer screen, one would readily admit that the observed phenomenon could easily be extended to implicit tests of memory. That is, frequently one is presented with the need to recall associations of words or words and numbers not previously presented as an explicit item to be recalled at a later date. Consider, for example, the need to remember a telephone number associated with a business advertised on a billboard or the name of a new acquaintance for which one initially only remembers the first letter of the name seen on a name tag. Seldom does one expect to be called upon to recite these associations in a direct test of memory, but the challenge to remember or forget frequently present itself in daily life, and the mode of initial presentation (e.g., billboard or name tag) likely has a significant impact on one's ability to recall those names, numbers or associations. Equally important, therefore, is the ability to forget former associations of the same ilk even when not explicitly told to forget the former address, number, or name.

The importance of the results reported in this paper extends beyond the typical tests of directed forgetting employed in this study. While only two colors and two fonts were tested for potential impacts on directed forgetting, clearly other fonts and other colors could yield different results. It is plausible that higher order interactions could be obtained merely by testing additional colors and additional fonts. Furthermore, the strengths of these effects could be affected differentially by the distinctiveness of the colors or fonts employed. Though only two colors and two fonts were used in only explicit tests of memory, it is possible that other font and color combinations could yield

even stronger results and possible significance in both the item and list methods of directed forgetting as well as implicit tests of memory. Furthermore, words viewed in this study were all deliberately presented in uppercase letters to reduce the visual or perceptual distinctiveness of the shapes of words presented in lowercase or title case. Though text is not normally encountered solely in uppercase in textbooks or other reading materials (with the obvious exceptions of titles and subtitles), this presentation of words in uppercase only reduced the possible influence that the distinctive shape of a word presented in lowercase letters might have the results. Though **ARIAL**—a sans serif font—and **TIMES NEW ROMAN**—a serif font, are visually different from each other even in uppercase merely because of the absence or presence of short lines or strokes at the ends of the serif characters, the visual distinctiveness of each is less than the lowercase presentation of words in **Arial** and **Times New Roman** fonts. Thus, uppercase presentation forced participants to focus on the distinctive nature of the font rather than the "shape" of the words being presented for encoding.

The addition of other variables could lead to higher-order interactions not explored in this or other studies. The size of the font—14 point versus 22 point—or the heaviness of the line used to present the words—normal versus bold versus italic—could have differing effects in either explicit or implicit tests of memory. The addition of a third font (script, for example), as well as a third color, could yield higher-order interactions not included in this study.

Perhaps even more important to one's ability to remember or forget a word (or number) is the familiarity or lack of familiarity of the typeface itself. While conventional

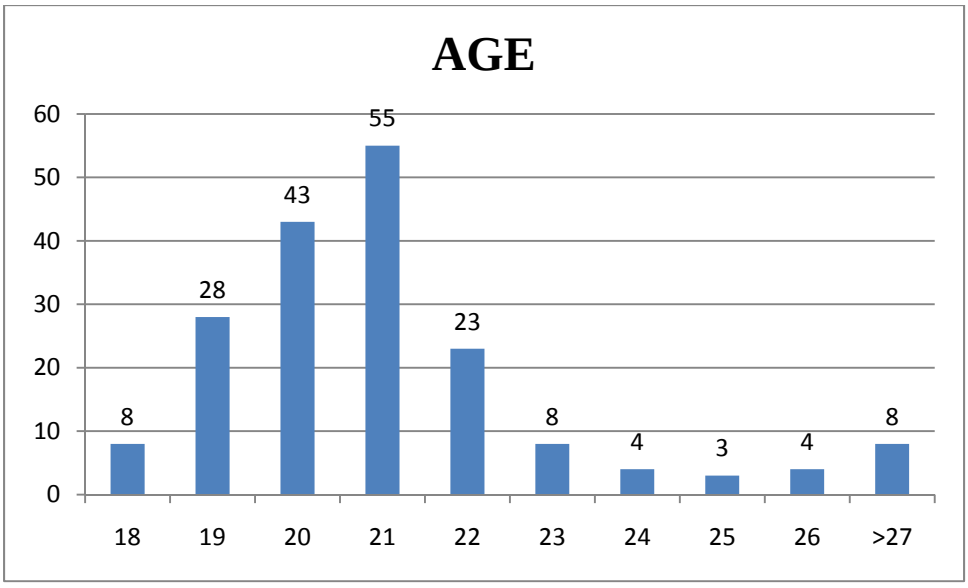
wisdom might suggest that more familiar fonts would be more easily remembered, it is clear from reading any textbook or technical manual that the font itself is not the sole determining factor in the salience of the words viewed. Despite the fact that italics, boldface type, and underscoring are routinely used to make items appear distinctive to the reader, it is clear that these items are distinctive primarily because they are different from the text in which they are embodied. The results obtained in this study suggest that other factors may also affect the ability of one to remember or forget that which has been viewed. Italics and boldface type achieve salience primarily because of their distinctiveness compared to other contiguous items embedded in the foreground. Nonetheless, background may also play a significant role in the perceptual distinctiveness of the items being viewed. For example, most books are printed with black ink on white paper though the author of this paper has used texts printed in blue ink on an off-white or gray background. This background color and the contrast achieved by pairing it with a particular color of ink and a particular font could also present significant variability in one's ability to remember or forget words read in a text. Thus, higher order interactions including background and contrast may have a significant impact on the directed forgetting phenomenon.

One must also consider that other variables could interact or co-vary with the variables included in this study. Motivation, for example, often plays a role in one's ability to complete a task successfully or focus strictly on the task being undertaken. This study involved only participants who voluntarily subjected themselves to the short task. It is clearly possible that interest in the task itself may have played a role in the results

obtained. Were some form of inducement offered to elicit participation in the task, different results might be obtained. Moreover, the degree of fatigue of the participants might also have played a role in their abilities to concentrate on the task even though the task was relatively short. Thus, it might be worth considering the roles that motivation and fatigue may play in one's ability to attend to specific directions to forget.

It is also important to consider the fact that the items presented in the research were all viewed on a computer screen. While they were all presented identically, viewing a computer screen is not the same as viewing a printed page. It is possible that materials printed on paper are perceived differently from those presented on a computer screen. However, as shown in Figure 3 all but five participants in this study were from 18-26 and would, therefore, be more likely to be accustomed to reading items on a computer screen.

Figure 3: Distribution of Participants by Age



Thus, the results were not likely affected significantly by the age distribution of the

participants. Nonetheless, use of older participants could reveal an age by treatment interaction.

Recommendations for Future Research

Though research on directed forgetting spans forty years, it appears that several aspects of this phenomenon are not yet fully understood. While the purpose of this study was limited to the possible interaction effects of two colors of font and two typefaces on the ability to remember and forget nouns, several other possibilities present fertile ground for future research. As already noted, the two fonts used in this research were chosen primarily because of their common usage in printed materials such as textbooks and journals. However, these two fonts by no means represent the broad range of fonts encountered on a daily basis by readers of other media. With the preponderance of communications distributed through the Internet and the concomitant freedom to choose any style of font one prefers in this medium, other fonts are encountered by users of electronic media on a daily basis. Furthermore, with an increasing number of educational institutions moving to online venues not only for distribution of materials in a timely fashion but for synchronous and asynchronous communications among students and faculty, the potential higher-order interactions of font, color, contrast, and background all deserve attention as factors potentially influencing the efficacy of the materials distributed and read in these forums.

This study was limited to testing for recall and recognition of familiar nouns. While verbs might present a different challenge for creating stories to remember words, especially in the list method of presentation, there is little initial reason to believe they

would be differentially affected by color and font. Other types of tests, however, should be tested for interaction effects between color and font. Whereas the recognition test elicited a significant interaction between font and color, this has not yet been tested in stem-completion or fragment tests. Though one might dismiss these tests as artificial mechanisms not worthy of further study, it would be precipitous to conclude that these formats are not encountered in at least a few real contexts. Foreign language classes found online often employ stem completion and fragment tests to teach vocabulary and reinforce spelling. Further, classroom-based and Internet-based language programs often use implicit memory tests involving paired associations of words (e.g., flashcard pairings of the cue with the corresponding foreign or native language word). Thus, the effects of font, color, background, and contrast should all be tested for possible effects on memory for the items presented in these manners.

The use of graphs, charts, and other symbolic representations of data in printed materials may also be influenced by the color and font used in their presentations. While television advertisers continually search for new tunes, annoying repetition of phrases, and catchy phrases to capture the attentions of their audiences, purveyors of printed materials need to direct their attention to more subtle characteristics of their documents. Though the adage that a picture is worth a thousand words may seem trite but true, it may be equally as important to consider that the colors and fonts used in a graph and charts may be worth more than simply the paper on which they are printed.

Because reading is an individualized experience, future research should investigate whether the combination of a particular font and color are related to the

particular perceptual preferences of an individual. Though most materials are printed in black print on a white background, the ease with which electronic materials can be presented in virtually any combination of font and color presents one with the question of whether or not differential presentations based on the preferences of the viewers would enhance a viewer's ability to remember or forget a particular item. It is plausible that background plays a more significant role in visual perception than distributions of written materials—printed or electronically delivered—have explicitly considered when developing materials for use by their customers.

Future research might also investigate the extent to which word shape plays a role in perception. Though many individuals have less than 20/20 vision, many are able to read printed materials without actually seeing the individual letters comprising the words because the shapes of the whole words are familiar. Much of this has to do with the grater variation in shape of lowercase letters, thereby making the visual cues more distinctive. With a current younger generation ostensibly more interested in rapid communicating than in correct grammar or capitalization (as evinced by the heavy use of lowercase letters (as well as letter-and-number-combinations) to convey a word or idea in cell phone text messages sent by youth, the effect of uppercase and lowercase letters on one's ability to remember (or forget) a message might be investigated further.

Finally, differences in perceptions of color and font should also be investigated in languages other than English. While the German language has managed to maintain its use of uppercase letters for all nouns, it has begun to change its use of the Scharfes “S” (i.e., ß) in favor of a double “s” to portray the same sound. Though this is a shift in

spelling, it is also a change in shape of the words using the Scharfes S and thus could be significantly impacted by the shape as well as the font type and color of the font in studies of directed forgetting as well as other studies of reading behavior. Languages using even more distinctively different alphabets might rely more heavily on word recognition through font type or color than English or other languages using the basic Latin characters.

Limitations of this Study

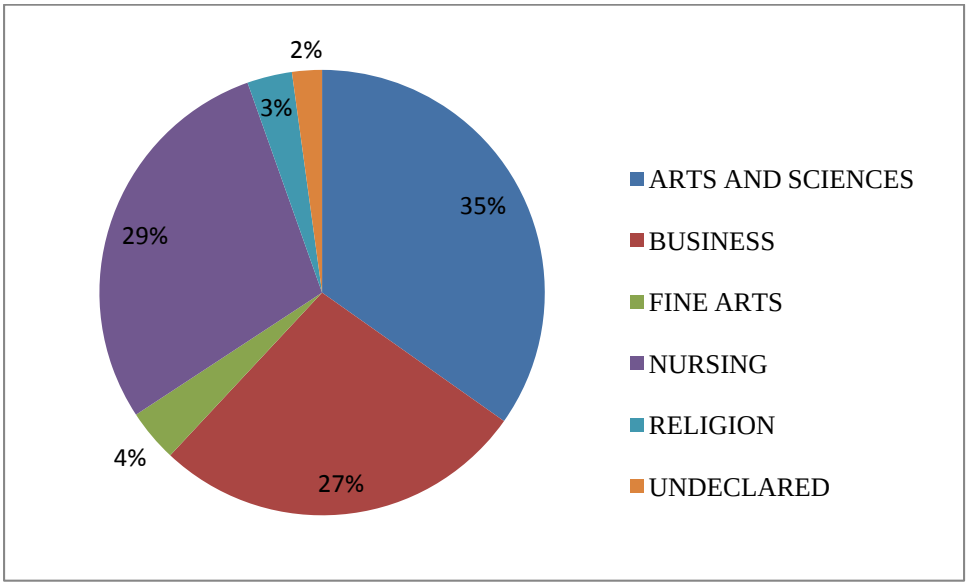
Though this study engaged the participation of a reasonable number of university students from the somewhat typical ages of 18-26, it did not include a significant number of older adults who may present very different responses to the computer stimuli used in this experimental procedure.[12] Additionally, all participants were from a single academic institution and therefore may not adequately represent the population of university students at more diverse institutions and most certainly would not represent the population of all readers. Furthermore, the distribution of majors represented by the sample is not representative of the entire student body of this single academic institution.

This study is also limited by the fact that all participants in the study were volunteers. While volunteers often exhibit those with a greater interest in the study, a more varied sample of participants from across the traditional age group for an undergraduate institution would possibly yield more salient results. First, volunteers may be more amenable to the task, and this could be a confounding variable. While volunteers are excellent candidates for participation, they do not necessarily represent the population of students enrolled in the typical university. Furthermore, the parochial

12 Refer to Figure 3 for the distribution of ages of participants in this study

nature of the university, its location in the southwestern United States, and its small total population of students (i.e., fewer than 2000) all limit the generalizability of the results to some extent. While history, instrumentation, mortality, maturation, experimenter effect, and subject effect were controlled to the greatest extent possible, the nine months required to obtain a sufficient number of participants to ensure normality of distribution represents a possible mitigating factor in the interpretation and generalization of the results. With the relatively long collection period, however, a greater distribution of participants from across the university was obtained. As depicted in Figure 4, the Schools of Fine Arts and Christian Service were underrepresented in the sample obtained. Despite this under-representation however, only mild cause for concern over the representativeness of the sample might be raised because the words used in the study were not peculiar to any area of study. Thus, the possible lack of a representative sample relates only to the characteristic population of the university and not to the ability to generalize to readers in general. Further, effects of the manipulated variables may affect either performance or functional dimensions not included in the study.

Figure 4: Distribution of Participants by Schools or Colleges



Conclusions

The purpose of this research was to extend the literature on the phenomenon known as directed forgetting. Specifically, this study was designed to determine what effect, if any, presentation format in terms of color and font might have on the directed forgetting process using two explicit tests (recall and recognition) and two modes of presentation (the list and item methods). The significance of this investigation lies not only in its contribution to the literature in general but in its contribution to our understanding of the often-overlooked impact that presentation mode of printed materials has on a reader's memory of a visual experience, in particular the experience of reading..

The significant finding of this research is that color interacts with font when individual nouns are viewed for six seconds immediately accompanied by a second direction to remember or forget the word during the final second of its six-second

presentation. This finding has major implications for the presentation of printed materials in a variety of situations. Given that previous research has demonstrated that differential rehearsal and retrieval inhibition are incomplete explanations of the directed forgetting effect, this research adds credence to the belief that distinctiveness of presentation plays a larger role in at least one of the two methods of presentation. The importance of this distinction should not be underestimated when presenting materials in books, projecting items on screens during presentations, or even when writing items on whiteboards using various colors of markers. The distinctiveness of the color and the font and even the handwriting could have a significant impact on what is later remembered by the viewer. Undeniably, visual perception of distinctive cues plays an important role in what one is instructed to remember as well as what one is directed to forget.

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APPENDIX A

Parameters for Word Selection

NAME		FAM	CONC	IMAG	MEANC	MEANP	AOA	BROWN-F
Mean		488	438	450	415	600	405	35
standard deviation		99	120	108	78	107	120	252
MIN		?	158	129	127	192	125	
MAX		657	670	669	667	922	697	
UPPER		700	700	700	700	700	700	
LOWER		100	100	100	100	100	100	
Standard deviations:	-3	191	78	126	181	279	45	-721
	-2	**290**	**198**	**234**	**259**	**386**	**165**	**-469**
	-1	389	318	342	337	493	285	-217
	0	488	438	450	415	600	405	35
	1	587	558	558	493	707	525	287
	2	**686**	**678**	**666**	**571**	**814**	**645**	**539**
	3	785	798	774	649	921	765	791

APPENDIX B

Words Selected from Online Psycholinguistic Database

ABODE
ABYSS
ADVICE
AGONY
AMOUNT
ANGLE
ANIMAL
ANKLE
APPLE
ARM
ARMY
ARRAY
ARROW
ARTIST
AVENUE
BABY
BANDIT
BARON
BARREL
BEAST
BELIEF
BIRD
BLOOD
BLOOM
BOARD
BODY
BOOK
BOSOM
BOSS
BOTTLE
BOWL
BOY
BRAIN
BREAST
BREEZE
BRONZE
BRUTE
BULLET
CABIN
CAMP
CANDY
CANE
CASH
CAT
CATTLE
CELL
CHANCE
CHAOS
CHARM
CHIEF
CHILD
CHIN
CHURCH
CIRCLE
CITY
CLAW
CLOCK
COAST
COFFEE
COIN
COLONY
COMEDY
CORD
CORN
CORPSE
COST
COTTON
CRADLE
CRIME
CRISIS
CUSTOM
DAMSEL
DEATH
DECEIT
DECREE
DEED
DELUGE
DEMON
DEVIL
DIRT
DOLL

DOVE
DRAMA
DREAM
DRESS
DUMMY
DUST
DUTY
EARTH
EFFORT
ELBOW
ENGINE
ERRAND
EVENT
EXCUSE
FABRIC
FACT
FATE
FLAG
FLASK
FLESH
FLOOD
FOAM
FOLLY
FORK
FORM
FOWL
FOX
FRIEND
FROG
FUN
GAIETY
GALAXY
GEESE
GEM
GENIUS
GHOST
GIFT
GILT
GIRL
GLORY
GOBLET
GOLD
GRASS
GREED
GREEN
GRIEF
HALL
HAMLET
HARP
HATRED
HEALTH
HEAVEN
HIDE
HOME
HOOF
HOTEL
HOUND
HOUSE
HURDLE
IDEA
IDIOM
IMPACT
INFANT
INJURY
INK
INN
INSECT
IRON
IRONY
ITEM
JAIL
JELLY
JOKE
JUDGE
JURY
KEG
KETTLE
KING
KISS
LAD
LARK
LAW
LAWN
LEMON
LENGTH
LICE
LIFE
LIMB
LIME
LINK
LIP
LORD
LOVE
LUMP
MAIDEN
MALICE
MANTLE
MARKET
MAST
MEADOW
MEMORY
MENACE
MERCY
METAL
METHOD
MIND
MIRAGE
MISERY
MOMENT
MONEY
MONTH
MOOD
MORAL
MOSS
MULE
NAIL
NEPHEW
NOOSE
NUN
NUTMEG
NYMPH
OPIUM
ORIGIN
OVEN
OXYGEN
PACT
PALACE
PANIC
PARTY
PATENT
PEACH
PELT

PENCIL
PERSON
PIANO
PIPE
PISTON
PLAIN
PLANK
PLEDGE
POET
POETRY
POTATO
PRIDE
PRIEST
PRISON
PROXY
PUPIL
QUEEN
QUEST
RATING
RATTLE
REVOLT
RITUAL
ROCK
SAFETY
SALAD
SALARY
SALOON
SALUTE
SAUCE
SEA
SEASON
SEAT
SERF
SERIES
SHADOW
SHAME
SHIP
SHOCK
SHRIEK
SIMILE
SKIN
SKULL
SKY
SLAVE
SLUSH
SNAKE
SOIL
SONATA
SOUL
SPEECH
SPIRIT
SPRAY
STAIN
STEAM
STORM
STRING
STUB
STYLE
SUDS
SUNSET
SWAMP
TABLE
TANK
TEMPLE
THEORY
THIEF
THORN
TICKET
TIDBIT
TIME
TOAST
TOMB
TOOL
TOY
TREE
TRIPOD
TRUCE
TRUCK
TRUTH
UNIT
UPKEEP
VACUUM
VALLEY
VANITY
VENOM
VESSEL
VEST
VICTIM
VIRTUE
VOLUME
WEAPON
WENCH
WHALE
WHEAT
WIFE
WIGWAM
WINDOW
WINE
WOMAN
WORLD
YACHT

3 letters	16
4 letters	88
5 letters	101
6 letters	109
Total	314

APPENDIX C

Institutional Review Board Approval

Oklahoma State University Institutional Review Board

Date:	Wednesday, May 28, 2008
IRB Application No	ED0879
Proposal Title:	The Effects of Color and Typeface on Directed Forgetting
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved Protocol Expires: 5/27/2009

Principal Investigator(s):

Roger D. Flint
1522 North Elm Ave.
Shawnee, OK 748044231

Dale Fuqua
444 Willard
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☑ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcteman@okstate.edu).

Sincerely,

Sheila Kennison, Chair
Institutional Review Board

VITA

Roger D. Flint

Candidate for the Degree of

Doctor of Philosophy

Dissertation: THE EFFECTS OF COLOR AND TYPEFACE ON DIRECTED FORGETTING

Major Field: Educational Psychology/REMS

Biographical:

Education: Received Bachelor of Science degree in English and Business Education (with emphasis in Accounting) from Southwest Baptist College, Bolivar, Missouri, in May 1979. Received Master of Business Administration degree from Southwest Missouri State University, Springfield, Missouri, in May 1980. Completed all requirements for Doctor of Philosophy in REMS/Educational Psychology at Oklahoma State University in December, 2009).

Experience: Employed as graduate assistant by Southwest Missouri State University while pursuing MBA. Employed by Oklahoma Baptist University as faculty member from August 1980 to present. Current rank: Associate Professor of Accounting

Certification: Certified Public Accountant, State of Oklahoma.

Name: Roger D. Flint Date of Degree: December, 2009
Institution: Oklahoma State University Location: Stillwater, Oklahoma
Title of Study: THE EFFECTS OF COLOR AND TYPEFACE ON DIRECTED FORGETTING

Pages in Study: 87

Major Field: Educational Psychology: REMS

Scope and Method of Study: The purpose of this was to examine the effects of color and typeface on the phenomenon known as directed forgetting using two well-established procedures of eliciting the effect. A total of 184 participants were randomly assigned to the list-method group or item method group, the ARIAL or TIMES NEW ROMAN typeface group, and the red or blue color group. Participants in both item and list method groups viewed 30 words for six seconds each on a computer screen which they were instructed to either remember or forget per the standard procedures applied in each of these procedures. After presentation of the 30 words, a short distractor task (select the capital of these states) was presented on screen. Then, the 89 participants in the ITEM method group were administered a recognition test which included the 30 words originally presented and 15 distractor words which had not previously been seen. All cues were presented in black typeface. The 95 participants in the LIST method were administered a recall task requiring them to type as many of the words they were instructed to remember as they were able to remember. The recall task ended when the time lapsing between entries exceeded 30 seconds.

Findings and Conclusions: Factorial ANOVA results revealed a significant interaction of color and typeface for the number of words correctly recognized ($F=.695$; $df=1$; $p=.419$). Factorial ANOVA results for the LIST method revealed a non-significant interaction of color and typeface for words correctly recalled ($F=6.104$; $df=1$; $p=.015$). Simple main effects tests revealed a moderate effect (partial eta squared = .07) for the color blue ($F=5.935$, $df=1$, $p=.017$), but a nonsignificant effect (partial eta squared=.02) for the color red ($F=1.514$, $df = 1$, $p=.222$). The results of the study suggest that perceptual cues play a more significant role in the ability of individuals to forget what they have been instructed to forget than may have been previously examined.

Advisor's Approval: _____