APPLICATIONS OF INTENTIONAL SUPPRESSION: THE EFFECT OF SUPPRESSION ON RECOGNITION MEMORY OF ECOLOGICALLY VALID STIMULI

by

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APPLICATIONS OF INTENTIONAL SUPPRESSION:

THE EFFECT OF SUPPRESSION ON RECOGNITION MEMORY OF

ECOLOGICALLY VALID STIMULI

Rhiannon Ellis Hart, M.S.

There are many situations in life when people try to forget information they have previously learned. It is therefore important to understand how to avoid negative memories. One method of evaluating how we actively forget, or suppress, information is to take advantage of a procedure known as the think/no-think (TNT) paradigm (Anderson and Green, 2001). In the TNT paradigm, individuals learn to associate pairs of stimuli, and must either rehearse or suppress one of the stimuli when presented with the other. The TNT paradigm allows for direct comparisons of forgetting rates of rehearsed and suppressed information. The goal of the present research was to consider the generalizability of the TNT paradigm. The first experiment involved the TNT paradigm and paired neutral words and nonverbal shapes in order to made old/new judgments and demonstrated that individuals are indeed capable of forgetting information using suppression, even when presented with the original stimuli and asked whether they have previously seen it, and even with nonverbal shapes as the stimuli. The procedure in Experiment 2 was similar to that of Experiment 1, but used neutral faces and positive, neutral, or negative words, and results indicated that individuals can use suppression to forget powerful, ecologically valid stimuli – namely, faces. This effect was most driven by instances when the cue to think about the faces was negative. Finally, the procedure for Experiment 3 mirrored that of Experiment 2, except with all neutral words and faces that varied in valence. Results demonstrated that individuals are better able to forget negative than neutral or positive faces when suppressing a neutral cue. These findings constitute a first step in a fundamentally advancing our understanding of real life forgetting experiences. The ability to forget information in difficult situations generalizes previous findings to more everyday situations. The fact that we can suppress faces implies we might be able to use suppression in real situations involving people of negative personal significance. Contrary to previous valence research, negative information was easier to suppress than neutral or positive information.

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PREFACE

No one completes a dissertation without the support of many people around them. First, I would like to acknowledge my dissertation committee members, Jonathan Schooler, Jim Becker, Bill Klein, and Julie Fiez, for their dedication, time and encouragement. When I thought that there would never be an end to my dissertation, Julie especially offered emotional support, more than I could have asked from anyone. In addition to the faculty at the University of Pittsburgh, there are a number of professions to whom I am greatly indebted. Mike Anderson has offered guidance, thoughts, and encouragement that have been instrumental. Betsy Gardner gave me a direction to aim, both personally and professionally. And last, but certainly not least, the woman I consider my lifelong mentor: Beth Loftus. Without Beth's introduction for me to research in memory, I have no idea where I would be. Beth has taught me to think, to take disappointment in stride, and to look for innovative ways of considering problems.

On a personal level, there are a number of people who have been a major part of this process for me. Looking to my past, I have always been able to count on my mother, for support, caring and (wanted or unwanted!) advice. Looking to my future, I can think of no better inspiration for completing higher education than showing my children the benefits thereof. They have motivated me far more than they will ever know. Finally, my friends, such as Daniela Birch, Mary Larios, Therese Hart, Evette Ludman, and Jennifer McClure: I would not have made it past that 24th mile without you. May I be able to someday offer the same support to you all as you have to me. Only a true friend threatens to disown you for considering giving up on something you love out of frustration.

1.0 INTRODUCTION

Throughout life, information becomes irrelevant, facts become discredited, and news becomes old. Sometimes we experience events that we would rather not think about, or situations that we know will unduly bias us. In circumstances like these, forgetting, the failure of memory that we often seek to escape, becomes our greatest virtue. We use our ability to forget information to update our knowledge, avoid distraction or rumination, and make objective decisions. Given the importance of forgetting, understanding how we might accomplish this forgetting is crucial to controlling and better utilizing our thoughts, decisions, and actions.

A new method for studying intentional memory inhibition is the think/no-think paradigm. In the following section, I will discuss what the think/no-think paradigm is and how it has been used to evaluate how individuals forget information in real life situations. I will consider current applications of this procedure. Finally, I will address how we might broaden the generalizability of the application of the think/no-think paradigm.

1.1 THINK/NO-THINK PARADIGM

Research has shown for decades that deliberate efforts to forget previously learned material can cause forgetting (e.g., Deese, 1965). More recently, a new paradigm has emerged called the think/no-think paradigm (TNT paradigm) that involves learning paired associates and later rehearsing or suppressing certain pairs (Anderson and Green, 2001). The TNT paradigm has provided evidence that merely trying not to think about (suppressing) information can reduce subsequent recall ability.

1.1.1 Procedure for the TNT paradigm

The basic procedure of the TNT paradigm involves three phases. First, participants study paired associates to a learning threshold. In the original version of this paradigm, both members of the paired associates were words. These pairs consisted of a cue word and a response word. Following the learning phase, participants viewed the cue word. For some cue words, participants are instructed to think about (rehearse) the associated response word. For others, they are instructed to avoid thinking about (suppress) the response word. Still other cue words are not presented at all during this think/no-think phase (TNT phase). Finally, in the test phase of the TNT paradigm, participants are given a memory test in which they are asked to recall all of the response words that they can. Results of this paradigm have revealed that, often even after only suppressing once, individuals are less able to recall suppressed word pairs than rehearsed word pairs. Further, with increasing numbers of TNT phase suppression trials, participants tend to lose even more of their ability to recall information (Anderson and Green, 2001)[1].

1.1.2 Implications of the TNT paradigm

Before discussing the applications others have made regarding the TNT paradigm, it is necessary to delineate what is meant by decreased memory performance when comparing suppressed stimuli to rehearsed stimuli, as well as what is meant by decreased memory performance when comparing suppressed stimuli to neither rehearsed nor suppressed stimuli. When we consider the difference between suppressed and rehearsed stimuli, we are comparing memory abilities in two situations where individuals are faced with cues that trigger a memory. In the former, individuals would avoid thinking about the memory associated with the cue. An individual in this situation might be trying to avoid thinking about an argument with a coworker who they see daily. In the

[1] While the overall effects of suppression described by Anderson demonstrated that increased suppression caused increased inhibition, this finding was not consistent across studies, even in the original paper. Whereas Experiment 1 and an averaging of Experiments 1 through 3 showed inhibition at the eight repetitions level, Experiments 2 and 3 did not show consistent inhibition for suppression with less than 16 repetitions. Suppression of eight repetitions appears to sometimes have the same effect as not having been exposed to a cue at all. While significant, this is not the same as saying that suppression reliably causes inhibition.

latter, an individual would attempt to think about the memory associated with the cue. An individual in this situation might try to think about a happy conversation with a coworker they see daily.

A comparison between stimuli that have been suppressed and those that were neither suppressed nor rehearsed, however, is comparing a situation where there is a cue to a memory that an individual wishes to avoid thinking about, compared to a situation in which there is no cue to think about the memory. This may involve trying to avoid thinking about an argument with a coworker that an individual sees daily, as opposed to an argument with someone that the individual does not see at all. This comparison, then, contrasts memory ability after actively attempting to not think about a target in the face of cues to memory ability after a lack of cues.

1.1.2.1 Paradigms contributing to the think/no-think paradigm

The idea that individuals might be able to exclude information from coming to mind has been considered previously by procedures reviewed below. When considering intentional suppression, we can borrow from the research of two related procedures: the list method of intentional forgetting[2], and retrieval-induced forgetting. Though they differ from each other and the TNT paradigm in methodology and results, each of these methods has added to our understanding of how individuals can control their thoughts and affect the accessibility of their memories.

(a) Intentional forgetting

In the list method of intentional forgetting, participants are given two lists of words to memorize; then they are tested to a certain criterion level of accuracy. Before the presentation of the second list, however, participants in the Forget condition are told that they do not need to remember the first list. Participants in the Remember condition are not told to disregard the first list (Muther, 1965).

Results from intentional forgetting research have illustrated that when given a later memory test, participants in the Forget condition are less able to remember the information from

[2] There is another method for testing intentional forgetting: the item method. However, this method is not clearly a procedure demonstrating forgetting of encoded information, and is instead seen as differential encoding. Thus, it is not included in this discussion.

the first list than participants in the Remember condition. That is, they are less able to remember the information that they were told they did not need to remember (the to-be-forgotten information) than participants who were instructed to remember both lists. Conversely, they are better able to remember the information that they were told to remember (the to-be-remembered information) than participants who were told to remember both lists (Whetstone, Cross, and Whetstone, 1996).

(b) Retrieval-induced forgetting

Retrieval-induced forgetting investigates how successfully recalling an item from memory can affect the accessibility of the other items. In retrieval-induced forgetting research, participants learn a list of items from multiple categories. For instance, GREEN items include *lime*, *grass*, etc. RED items include *blood*, *tomato*, etc. After learning all information to equivalent performance levels, target information from some categories is rehearsed while other information is not rehearsed. Additionally, some categories have no information rehearsed. For instance, the participant might rehearse *blood* from the RED list, but nothing from the GREEN list. Then, participants attempt to remember all of the information they initially learned. Research demonstrates that if an individual has practiced the item *blood*, their memory for the word *tomato* is inhibited. This does not affect the accessibility of members of the GREEN category, however, as they did not need to be inhibited in order to aid in the memory success of *blood*. This effect has been hypothesized to be due to suppression of unrehearsed items (Anderson and Bell, 2001).

1.1.3 Factors in generalizing of the TNT paradigm

The results of studies using the TNT paradigm are cited as evidence that suppression is a controlled process used to inhibit familiarity, a measure of automatic activation of memory, especially active when explicit memory fails (Hedden and Park, 2003; Windmann, Urbach, and Kutas, 2002). Other researchers have applied the TNT paradigm to real life forgetting, claiming that the TNT paradigm shows how individuals can forget ecologically valid information such as emotional memories (Smith, Gleaves, and Pierce, 2003). Still others have gone farther, claiming

that the TNT paradigm is evidence of the existence of Freudian Repression, specifically tying this paradigm to issues such as traumatic memories (Conway, 2001; Schacter, 2001).

In order to connect the TNT paradigm to such real-life situations, it is necessary to establish the generalizability of the initial suppression findings reported by Anderson and Green (2001). The present research specifically concerns three main questions: First, how extensive is the forgetting that is seen in the TNT paradigm in the face of powerful contextual cues? If we know that memory impairment is demonstrated using recall tests, can we also produce impairment using memory tests that offer more salient cues, such as those offered in a recognition test? Second, can the forgetting that we see using words be generated when we use more powerful stimuli, such as nonverbalizable shapes or faces? The use of faces specifically offers us the chance to consider the possibility of forgetting people using this paradigm. Finally, is forgetting possible with stimuli of varying valence? If so, what are the factors that affect memory specifically? For instance, is the fact that the stimuli are emotional enough to change how easily they can be forgotten, or does the direction of the valence matter? While the TNT paradigm has not yet considered these questions, intentional forgetting and retrieval-induced forgetting have made inroads into generalizing memory findings in these areas.

1.1.3.1 Cues to remember

When individuals fail to remember information, this can be due to multiple causes. If the individual was unable to remember information on a free recall test, it may be that there were not enough contextual cues available for them to access subthreshold memories. By contrast, recognition memory tests, when presented with the stimulus used at learning, often decreases possible forgetting. This may be due to an inability in free recall to access more powerful cues observed in the presented target item. Testing memory by asking whether something was learned before is an extremely powerful cue, in that it provides a great deal of information to trigger memory. The use of recognition tests in measuring accessibility speaks to a lowered threshold for retrieving information that might be available, given enough cues (e.g., Cohen and Nodine, 1978). There may be situations in which information is still present in memory, but free recall will fail to provide enough of a cue to access it. The use of recognition tests allows for additional cues to access that information. Accordingly, a lack of accessibility on a recognition test is a stronger indicator of forgetting than a lack of accessibility on a recall test.

Additionally, the use of recognition tests reduces interference from irrelevant information (Wallace and Page, 1982). By contrast, when recalling information, it may be difficult to select out only the information that is wanted and not all information that is available. Some information may be made more accessible through semantic priming (Collins and Loftus, 1975). Other information may be more accessible due to episodic priming, such as having been encoded at the same time or under similar circumstances (Hayes and Bissett, 1998). Clearly, there is inter- and intra-item interference evident in recall tests, but recognition tests tend to be more immune to these effects, due to the restricted nature of the test.

Some intentional forgetting research has shown memory deficits using both recall (Fleck, Berch, and Shear, 2001; Sahakyan, 2004) and recognition (Tekcan and Aktürk, 2001) techniques, while other research has shown that recognition serves to ameliorate the inhibitory effects seen with free recall (Basden and Basden, 1998). There have been numerous studies involving retrieval-induced forgetting showing memory impairment through both recall (Anderson, Bjork, and Bjork, 1994; Anderson, Bjork, and Bjork, 2000) and recognition tests (Hicks and Starns, 2004; Veling and van Knippenberg, 2004). Within the realm of the TNT paradigm, however, the only research that has previously been conducted has used recall as the dependent measure, instead of recognition.

1.1.3.2 Stimuli types

There are many types of information that individuals might try to forget. While there may be situations in which individuals try to forget words, it is important to understand what restrictions there are on the ability to forget information through suppression. While there are times when individuals may want to forget words (such as learned facts or passwords), there are many other situations as well that may be candidates for suppression. In some cases, individuals may want to avoid thinking about experiences that are difficult to put into words (such as experiences that are emotionally troubling, though it is hard to explain why). In others, individuals may try not to think about specific people with whom they have had negative experiences. In each of these situations, it is necessary to extend our understanding of the reach of forgetting effects from suppression. Specifically, are individuals able to forget more complex and powerful stimuli, such as nonverbalizable shapes and faces, as well as they forget words?

Many researchers have shown that intentional forgetting of words impairs memory (Woodward and Bjork, 1971). These findings of inhibition of memory have also been extended to pictures (Bjork and Bjork, 2003; Foster and Gavelek, 1983; Lehman, Morath, and Franklin, 1998). Various experiments have also demonstrated greater forgetting for nonpracticed same-category items with word lists (Smith and Hunt, 2000), pictures (Ford, Keating, and Patel, 2004; Shaw, Bjork, and Handal, 1995), locations (Ciranni and Shimamura, 1999), and oral stories (Bylin and Christianson, 2002). Thus, all of these procedures have shown at least some impairment on memory with varying types of stimuli.

When considering the strength and persistence of the forgetting found in the TNT paradigm, it is unclear whether the suppression-related forgetting extends to stimuli other than words. It may be that visual or auditory information will add a level of salience to the paradigm, releasing the inhibition that is caused by short-term suppression. For instance, the memory of the words of an old school book may not be enough of a trigger to remember that the book was stored in the attic, but the smell of dust may be an adequate trigger. If we find that the TNT paradigm does not cause inhibitory memory effects with nonlexical stimuli, then the TNT paradigm may not be the most realistic explanation for why individuals forget information in life. While much of what we experience in life involves words, there are situations in which our experiences are more abstract or nonverbalizable in nature. On the other hand, if individuals still experience inhibition with nonlexical stimuli, then the TNT paradigm remains a viable account for real life forgetting.

1.1.3.3 Valence

When individuals attempt to suppress information, the motivation (avoiding thinking about a target) implies that there is something negative about the outcome of what would happen if the individual did think about the target. While in some cases, this negative outcome may not be based on the emotional nature of the target (for instance, sometimes thinking about neutral or positive things can be a distraction), there are clearly many times when individuals will want to avoid thinking about negative experiences as well. Suppression results in forgetting of neutral stimuli, as has been demonstrated in the past, but to truly understand possible applications and limitations of the TNT paradigm, we must consider stimuli that are either positive or negative. In so doing, we are better able to conceive of the scope of the forgetting effects of suppression.

When tested with positive and negative words in an intentional forgetting paradigm, participants forget both positive and negative words. There are, however, higher forgetting rates for positive words than negative words (McNally, Clancy, and Barrett, 2004). Other research has demonstrated that participants identified as "repressors" (those reporting having previously repressed experiences) were more likely to forget negative information than nonrepressors in an intentional forgetting study (Myers, Brewin, and Power, 1998). In both of these studies, as in many like them, only positive and negative stimuli are considered; neutral stimuli are not included. Participants in retrieval-induced forgetting research also demonstrate forgetting of nonpracticed items, irrespective of valence, though to differing degrees. Nonpracticed memories of all valence types are inhibited, compared to competing practiced memories, though the most forgetting is evidenced in positive and negative memories respectively (Barnier, Hung, and Conway, 2004). For personally relevant information, however, participants with General Anxiety Disorder do not produce the same findings for negative stimuli, though they did for neutral and positive stimuli (Amir, Coles, Brigidi, and Foa, 2001).

1.2 PRESENT CONCERNS

The present research addresses the generalizability of the TNT paradigm and the efficacy of suppression, given three variables. First, is forgetting possible through a recognition test, even given salient contextual cues? Second, is forgetting possible for stimuli that are likely to be seen in real life situations, such as the memory of faces? Finally, does valence of stimuli have an effect on forgetting success?

1.2.1 Recognition tests

Research into the TNT paradigm has thus far been limited to recall tests of memory – both same cue and independent cue recall tests. While each of these tests is important, evidencing that forgetting is induced in episodic memory and priming is inhibited due to intentional suppression respectively, what is still unclear is whether that same inhibition would remain in the face of

extremely salient cues. Would individuals still forget, even when presented with the most salient cue possible, the target itself, in a recognition test? Would, on the other hand, the substantial level of cuing provided by a recognition test demonstrate that the forgetting seen in previous research does not extend to recognition memory tests?

All three experiments test memory performance through recognition tests. During the final test phase of Experiment 1, with shapes, and Experiments 2 and 3, with faces, participants are presented with the target stimuli (the shapes/faces that were rehearsed or suppressed) and asked to identify whether they had learned that shape/face before. If suppression is successful at a fundamental level, participants would be expected to forget more suppressed than rehearsed stimuli.

1.2.2 Types of stimuli

Previous research using the TNT paradigm has involved words as stimuli. In order to validate the TNT paradigm as a reasonable method of forgetting of other information types, it is necessary to know if this research can generalize to more complex stimuli types. If the TNT paradigm only works with words, this might serve to limit its applicability to situations in which it could be utilized. Previous research has shown that the TNT paradigm is effective for lexical information, but what about visual information in the absence of lexical information? Likewise, we must consider stimuli that we are likely to encounter in real life such as faces of new individuals.

Experiment 1 considers visual stimuli that are nonverbalizable, in this case, shapes that are designed to be difficult to describe. This way, they cannot be associated with words in one's lexicon. This adds to the generalizability of the TNT paradigm in that it does not solely rely on a person's memory of a word (i.e., lexical information). When one encounters a novel situation that is not lexical in nature, can the use of intentional suppression as demonstrated in the TNT paradigm reduce the accessibility of that memory?

Experiments 2 and 3 consider stimuli that are faces. Faces are nonverbalizable and are more commonly encountered in real life than nonverbalizable shapes. When using faces as our stimuli, we can begin to consider whether it is possible to suppress information about those we encounter. In addition, faces appear to have numerous special properties. Neuroimaging research into the fusiform gyrus has demonstrated that faces are recognized differently than other objects

(George, Dolan, Fink, Baylis, Russell, and Driver, 1999; McCarthy, Puce, Gore, and Allison, 1997). Research into processing of facial features shows that individuals process faces in a holistic fashion, rather than based on a modular deconstruction of features (Gauthier, Curran, Curby, and Collins, 2003; Pellicano and Rhodes, 2003). Thus, whether individuals are able to forget faces extends substantially the importance of suppression utilized by the TNT paradigm by proving that forgetting is possible even with stimuli requiring special processing.

1.2.3 Valence of stimuli

Another issue that is central to the generalizability of the TNT paradigm is the fact that not all stimuli that individuals want to suppress are neutral. Whether something is positive, neutral, or negative may have some degree of effect on how well individuals are able to suppress information, whether due to motivation, experience, or something else entirely. This seems especially likely, given that findings in the other discussed paradigms have tended to show such differential memory effects.

Experiment 2 includes cues words that are positive, neutral, and negative. Thus, while the faces paired with the words are neutral, the words used to cue the faces vary in valence. When exposed to words that are positive or negative, the emotional nature of the word may affect the ability to suppress the face. This difference may be due to an inability to engage in more complex executive control processes due to the emotional nature of the cue. Specifically, it may be too difficult to disengage from the cue in time to prevent thoughts of the target from entering the mind. On the other hand, the valence of the word may provide enough contextual cues associated with past experiences of successfully intentionally suppressing for accurate memory. It may be that individuals will be most successful suppressing information that they have the most experience suppressing, and certainly negative information is what individuals generally have the most motivation to forget.

Experiment 3 includes neutral words cuing faces that are positive (e.g., happy), neutral, or negative (e.g., sad, angry). Instead of the immediately presented information being positive, neutral, or negative, the associated face is positive, neutral, or negative. This experiment most closely generalizes to real situations where individuals might attempt to intentionally suppress memories of negative experiences with another individual.

2.0 EXPERIMENT 1

Experiment 1 considers two related issues bearing on the generalizability of the TNT paradigm: First, the stimuli used are shapes instead of words. If suppression of shapes is successful, it means that information that can be suppressed in the TNT paradigm need not be lexical. That is, this paradigm is not limited to a laboratory setting wherein participants are learning and suppressing word lists, but instead can be applied to other sorts of learned information as well. Second, the stimuli used are nonverbalizable. This manipulation eliminates the confounding variable that the shapes are visual, but encoded lexically anyway.

If the TNT paradigm were indeed to serve as a possible model for the forgetting of more significant experiences, one of the critical issues is to assess the potency of the forgetting. Some critics of the applicability of the TNT paradigm to the topic of traumatic forgetting have noted that the forgetting in this paradigm is relatively modest as indicated by the sheer number of items that are forgotten (Garry and Loftus, 2004). However there are two ways of assessing the magnitude of forgetting. One is to measure the degree to which suppression increases the proportion of items that are not retrieved. Another is to ask how difficult it is to retrieve those items whose accessibility has been altered by suppression. It seems quite plausible that while the TNT paradigm may only produce forgetting for some items, when such forgetting does occur, it may occur in a relatively robust manner. Such an observation would potentially be consistent with forgetting of trauma, in the sense that these memories are often well remembered (suggesting that suppression is often ineffective), but are at least occasionally reported to have been completely forgotten. This suggests that when suppression takes effect, it may be relatively complete (Williams, 1995).

One of the critical questions necessary for assessing the potency of the forgetting of those items whose accessibility is reduced through suppression is determining whether the forgetting persists in the presence of additional contextual cues. In several forgetting paradigms it has been

observed that reductions of accessibility are relatively fragile, such that items that are not accessible with free recall become accessible with recognition (Basden and Basden, 1998). If the forgetting associated with the TNT paradigm is such that it cannot be maintained in the face of the additional contextual cues associated with recognition, its applicability to other types of forgetting is clearly quite questionable. For instance, the application of this research to situations in which people are queried specifically about their experiences would not be appropriate.

On the other hand, it is possible that even if the TNT paradigm did not generalize to a recognition paradigm, it still might potentially have some relevance to the forgetting of traumatic material. The absence of recollection of a traumatic memory could be the result of a failure to encounter the specific contextual cues that would prompt activation of the memory. Nevertheless, if the TNT paradigm reduces forgetting to the extent that it persists even when participants are directly confronted with the previously studied item, then this would suggest that it induces a relatively robust form of forgetting and thereby bringing us one (albeit modest) step closer to the claim that the TNT paradigm may provide a basis for more profound varieties of forgetting.

2.1 METHODS

2.1.1 Participants and design

Forty-nine introductory psychology students from the University of Pittsburgh participated in this 3 (not presented, presented once, or presented eight times in phase two) x 2 (rehearsed or suppressed) within-participants experiment.

2.1.2 Materials and procedure

Fifty words were paired with 50 nonverbalizable shapes and were used as studied items. Eighty-three additional nonverbalizable shapes were used as fillers. Shapes were designed to be specifically hard to verbalize, and obtained using guidelines set by Attneave and Arnoult's

Method I for the construction of nonverbalizable shapes (1957). The words used were concrete, high-frequency nouns. They were selected from *Affective Norms for English Words* (ANEW; Bradley and Lang, 1999).

During the initial phase of the study, the List Learn phase, participants were shown each word and shape pair side-by-side on a computer screen for four seconds. Participants were given instructions to memorize the pairs for a later test. They were additionally instructed not to attempt to verbalize the shapes presented. This was to assure that participants did not attempt to think of the shapes as words. Following the single presentation of each word-shape pair, participants were tested on their ability to recognize the shape that had been paired with a given word. This was accomplished by presenting the word on the screen for three seconds. Below the word, four shapes were shown, one of which was the shape paired with the word. Participants were asked to select the key on the keyboard that corresponded to the correct shape before the three seconds had elapsed. Following the presentation of the word and shapes, the correct shape was shown, and the test continued to the next item. Participants continued to be tested until they achieved 50% accuracy. All participants achieved at least 50% accuracy by the third presentation cycle.

Participants then began the second phase, the think/no-think phase (TNT phase). Here, participants were required to either rehearse or suppress word-shape pairs in a manner similar to the previous phase. However, they were cued as to whether they should rehearse or suppress based on the color of the fixation cross and word that immediately followed it. For pairs that were to be rehearsed, the method was the same as in the List Learn phase. Pairs that were to be rehearsed were presented in green following a green fixation cross. The word was presented at the center of the screen, and four shape options were shown at the bottom. Participants were instructed to identify the shape that matched the word on the center of the screen and key the correct response on the keyboard. Following this presentation, the correct answer was shown.

For items that were to be suppressed, the method was slightly different. The word was presented in red following a red fixation cross. Instead of seeing four possible shapes, participants were presented with four empty boxes at the bottom of the screen. They were instructed *not to respond* to the word in this situation, and instead to avoid thinking about the related shape. In the suppress trials, participants were not provided with the correct response. All

pairs were presented zero, one, or eight times[3]. Each pair that was presented was categorized as either rehearse, suppress, or never shown. Some pairs were rehearsed once, some were rehearsed eight times. Other pairs were suppressed once, whereas others were suppressed eight times. Still others were not presented in this phase at all, and so were neither rehearsed nor suppressed (NRS).

Following a filler activity, participants entered the Final Test phase. Participants were presented with 100 shapes. Of those 100 shapes, 50 were members of the word-shape pairs and 50 were shapes that were never paired with a word. For each shape, participants were asked whether they had previously seen it paired with a word. Shapes were presented one at a time, and stayed on the screen until participants made old/new judgments. After the presentation of all 100 shapes, participants were debriefed.

2.2 RESULTS

2.2.1 Overall recognition accuracy

An analysis of variance (ANOVA) examining accuracy of old/new judgments showed significant differences between conditions for action during TNT phase (rehearse, suppress, or NRS), number of repetitions, and interaction, F (2, 96) = 65.561, $p < .001$, F (1, 48) = 20.852, $p < .001$, and F (2, 96) = 4.708, $p = .011$, respectively.

Overall, shapes that were rehearsed were more likely to be correctly identified as "old" than shapes that were suppressed, t (48) = 11.507, $p < .001$. Indeed, shapes that were suppressed appeared to attain no more than roughly 50% accuracy in participants' identification of them as old, t (48) = 3.412, $p > .05$. While there was no difference between shapes that were suppressed once and suppressed eight times, $t < 1$, shapes that were rehearsed eight times were significantly more likely to be judged as old than shapes that were rehearsed only once, t (48) = 6.423, $p <$

[3] While 16 repetitions would have been preferable, it was not feasible, given time and participant constrictions. After careful consideration, it was determined that eight repetitions did show a meaningful enough effect to use.

.001. There was a significant difference between NRS shapes and all other conditions. That is, NRS shapes were significantly more likely to be identified as old than shapes that were suppressed at least once, S1: t (48) = 9.108, p = .004; S8: t (48) = 10.789, p = .002, and significantly less likely to be identified as old than shapes that were rehearsed at least once, R1: t (48) = 5.981, p = .018; R8: t (48) = 79.369, p < .001. When participants suppressed shapes, they were less accurate than when they were simply not exposed to cues at all during the TNT phase. Finally, NRS items were significantly more accurately remembered than chance (p > .10). (See Figure 1.)

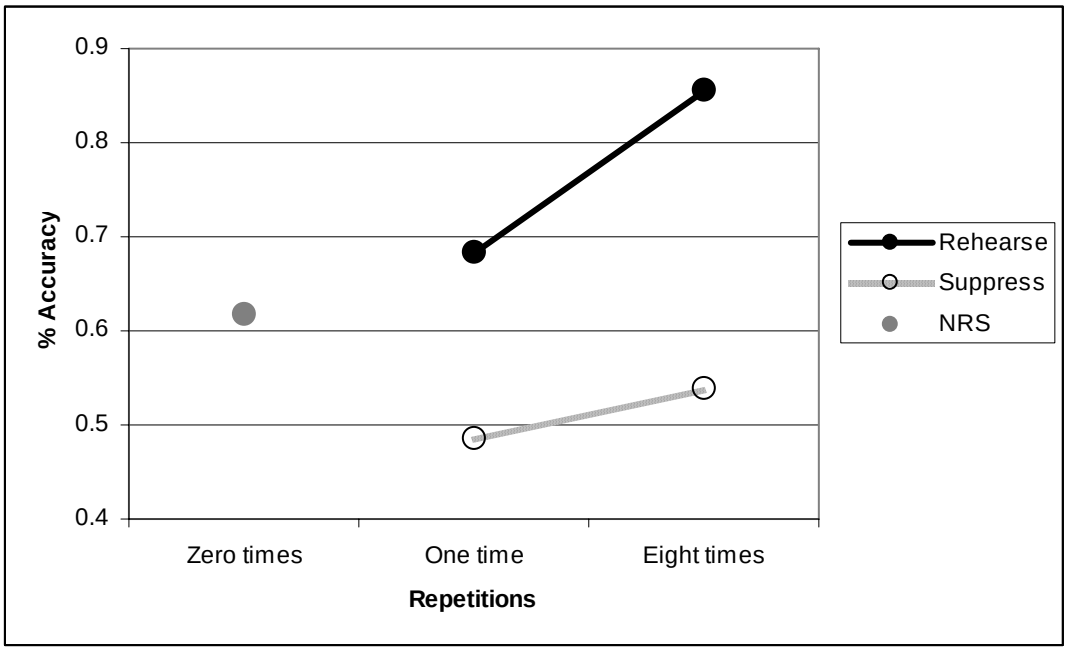

Figure 1. Percent of trials accurately identified as "old" on the final test, as a function of condition in Experiment 1.

2.3 DISCUSSION

This study makes two points: First, when presented with nonverbalizable stimuli, participants are less accurate and slower when they suppress the associations they learned as compared to when they do not suppress. This result appears to demonstrate that the previous research findings regarding the inhibitory effects of the TNT paradigm do transfer to nonlexical stimuli. While this

does not mean that shapes (the current stimuli) and words (the previous stimuli) are treated the same in memory, it is indicative that intentional thought suppression does indeed work for a variety of stimuli and is not simply a method of suppressing words from immediate awareness. Second, when participants were asked whether they had previously seen the stimuli, they were less accurate in their abilities to correctly recognize old items after suppressing the stimuli as compared to when they did not suppress. This is consistent with the pattern of results seen in recall memory TNT research, and extends those findings. This indicates that even though the information is easier to access given memory cues, there is the potential for information to be inaccessible, even in the face of direct cuing.

These findings are similar to previous research (Anderson and Green, 2001) in that rehearsed items remained better remembered than suppressed or NRS items, and suppressed items were less well remembered than rehearsed or NRS items. This implies that, even in the face of direct cuing, the use of suppression does cause inhibition in memory, as measured by recognition. While there was no direct evidence that the additional suppression attempts results in inhibition, the present research did not include as many suppression attempts as previous research has. If participants had suppressed up to 16 times, it is possible that the increased number of suppressions would have a greater inhibitory effect on memory. Indeed, the difference between one and eight suppression attempts has not consistently been shown to result in increased inhibition, as is especially evident in independent cue recall tests (Anderson and Green, 2001). On the other hand, increased suppression does not inevitably lead to increased inhibition. Ciranni and Shimamura (1999) found through their retrieval-induced forgetting experiment that, even after having participants rehearse target information multiple times, inhibitory effects for nontarget competitors did not increase beyond the effect of minimal retrieval. Thus, given the similarity between the TNT paradigm and the retrieval-induced forgetting procedure, we can extrapolate that it is not necessarily the case that increased presentations will lead to greater impairment.

3.0 EXPERIMENT 2

It is now clear that suppression leads to forgetting, even in the face of salient retrieval cues, as well as when using visual stimuli. A next step in considering the generalizability of the TNT is to look at the ability to forget more ecologically valid stimuli. While we encounter words often enough in our lives, we are social creatures and regularly encounter people whose faces we must process. Invariably, not all of our social interactions will be positive, and in order for us to successfully suppress memories of negative social interactions, we must have some method of avoiding thinking about those individuals involved. It is therefore important to consider the ability to suppress stimuli such as faces.

Faces are unique in the way that we process them. They are considered difficult to verbalize, and attempts to do so can worsen our abilities to remember faces accurately later (Fallshore and Schooler, 1995). Additionally, faces are encountered so regularly that we are specifically attuned to pay them special attention. Across species, special neural processing systems have been specifically dedicated to the processing of faces and expressions (Bruce and Young, 1986).

Additionally, in considering how we remember, we must note that not all cues are positive. Sometimes the cue causing us to think about a certain individual is negative (for instance, seeing a scary dog might cause a child to think of when they were once bitten), or positive (for instance, seeing happy children playing may cause a grieving parent to think about a deceased child). Valence of the cue is therefore also relevant. There is often a difference in the abilities of individuals to remember or forget information in intentional forgetting and retrieval-induced forgetting research, based on valence of the stimuli. Individuals are able to forget information in retrieval-induced forgetting paradigms, though the research equivocates on whether it is easier to forget positive (Amir et al., 2001) or negative information (Barnier et al., 2004). Repressors (individuals who reported having previously repressed a memory) are more

likely to forget negative information than nonrepressors in intentional forgetting research (Myers, et al., 1998). What is not evident is the effect of the valence of the cue on the efficacy of suppression. There are times when the information that is being rehearsed or suppressed may be accessed by an emotional cue. One such situation might be the experience of scenes about sexual abuse in a movie bringing about memories of having experienced abuse (Schooler, Ambadar, and Bendiksen, 1997).

The purpose of Experiment 2 is to evaluate the effect of more ecologically valid stimuli, as well as varying the valence of cue information. Instead of using words or shapes, we use faces as the target that participants are to remember or forget in the TNT phase. Experiment 2 additionally includes manipulations of the valence of the cuing stimuli. Cue information in Experiment 2 is positive, neutral, or negative, paired with a neutral target face. This allows for an examination of memory ability across a range of potential emotional (or unemotional) cues. Experiment 2 therefore adds to the generalizability of the suppression in the TNT paradigm, making is more akin to realistic social situations with an added depth of complexity of both the targets and cues.

3.1 METHODS

3.1.1 Participants and design

Sixty-seven University of Pittsburgh and Fairfield University students participated in this 3 (not presented, presented once, or presented eight times in phase two) x 2 (rehearsed or suppressed) x 3 (positive, neutral, or negative word) within-participants experiment.

3.1.2 Materials and procedure

First, participants learned to pair 60 words (20 positive, 20 negative, and 20 neutral) and 60 faces. As in Experiment 1, cue words were selected from the ANEW list (Bradley and Lang, 1999). The faces were designed using the facial composite program, FACES 3.0. Both targets

and foils were equally likely to be male or female and African-American or Caucasian. Targets and foils shared similar features, though each face was unique and no feature was used more than four times. There were also 60 additional faces used as foils in the final test, as well as 60 distracter faces. Participants were presented with a word paired with a face. As in Experiment 1, participants were trained to 50% accuracy on the associations. Then they rehearsed and suppressed zero, one, or eight times. Finally, participants were given a recognition test on 120 faces in order to make old/new judgments.

3.2 RESULTS

3.2.1 Recognition accuracy: Condition.

An ANOVA considering accuracy of old/new judgments showed significant differences between conditions for action during TNT phase and an interaction, F (2, 198) = 25.437, $p < .001$ and F (2, 198) = 37.574, $p < .001$, respectively.

Overall, rehearsed faces were more likely to be correctly identified as “old” than suppressed or NRS faces, t (66) = 7.243, $p < .001$ and t (66) = 5.634, $p < .001$, respectively. Thus, rehearsal caused greater accuracy overall. There was a significant difference between R8 and S8 faces as well as a significant difference between R1 and S1 faces, t (66) = 11.009, $p < .001$ and t (66) = 2.013, $p < .046$, respectively. In addition to this, there was a significant difference between R1 faces and NRS faces, t (66) = 2.411, $p = .017$. This demonstrates that the overall inhibitory effect of suppression is driven by increased repetitions. Additionally, there was a significant difference between R1 and R8 faces, t (66) = 6.333, $p < .001$, as well as S1 and S8 faces, t (66) = 2.827, $p = .005$, furthering the previous importance of repetition. Thus, suppression did cause inhibition, increasing with the number of repetitions. Finally, participants were significantly more accurate than chance in recognizing NRS items, t (66) = 62.097, $p < .001$. (See Figure 2.)

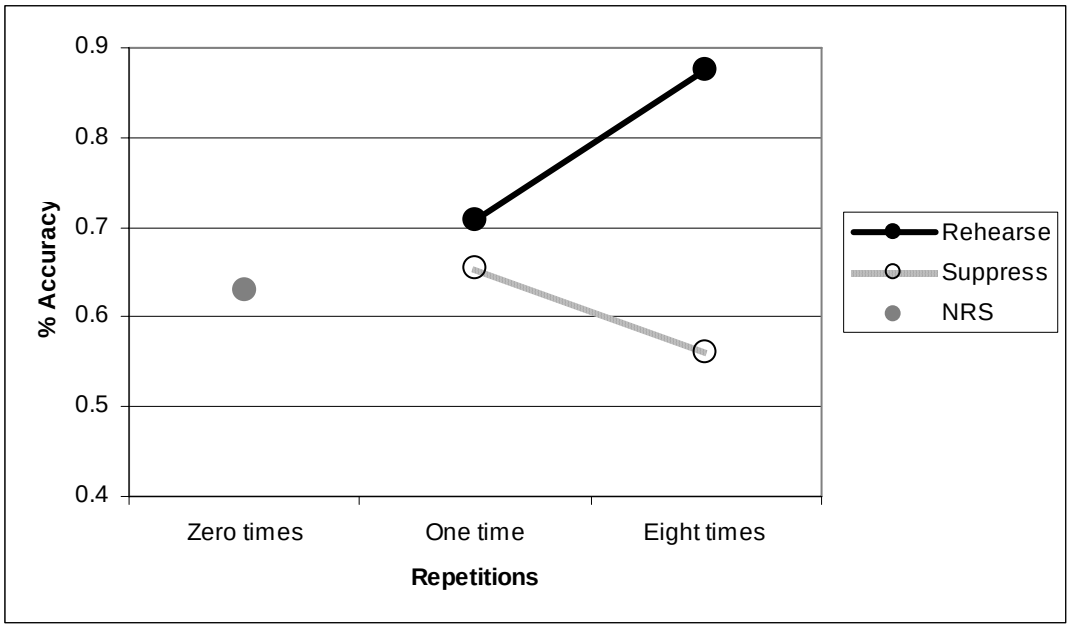

Figure 2. Percent of trials accurately identified as "old" on the final test, as a function of condition in Experiment 2.

3.2.2 Recognition accuracy: Valence of cue word

An ANOVA of the effect of the valence of the face on accurate recognition showed a main effect for valence, as well as an interaction between valence and condition, F (2, 198) = 5.966, p = .003 and F (4, 396) = 4.678, p < .001, respectively.

When considering the effect of valence of the word on accuracy, participants were more accurate with positive words than with neutral words, t (66) = 3.494, p < .001. The pattern of inhibition changed based on whether the face was positive, neutral, or negative. When the word was positive, rehearsed faces were more accurately identified than either suppressed or NRS faces, t (66) = 5.960, p < .001 and t (66) = 7.114, p < .001, respectively, and suppressed faces were more accurately remembered than NRS faces, t (66) = 2.043, p = 044. Thus, when reacting to a positive cue, recognition was best when the cue was rehearsed, followed by suppressed, and least effective when not rehearsed or suppressed.

When the word was neutral, rehearsed items were more accurately identified than either suppressed or NRS faces, t (66) = 4.171, p < .001 and t (66) = 4.043, p < .001, respectively. There was no significant difference between suppressed and NRS faces, t < 1. Thus, when

reacting to a neutral word, rehearsal was the most beneficial, followed equally by NRS and suppressed faces.

Finally, when the word was negative, rehearsed faces were more accurately identified than either suppressed or NRS items, t (66) = 7.072, $p < .001$ and t (66) = 2.528, $p < .013$, respectively, and NRS faces were more accurately remembered than suppressed faces, t (66) = 3.779, $p < .001$. Additionally, all NRS faces were more accurately recognized than at a chance level, t (66) = 5.726, $p < .001$. Therefore, when reacting to a negative word, rehearsal was the most beneficial, followed by NRS, and then suppressed faces. (See Figure 3.)

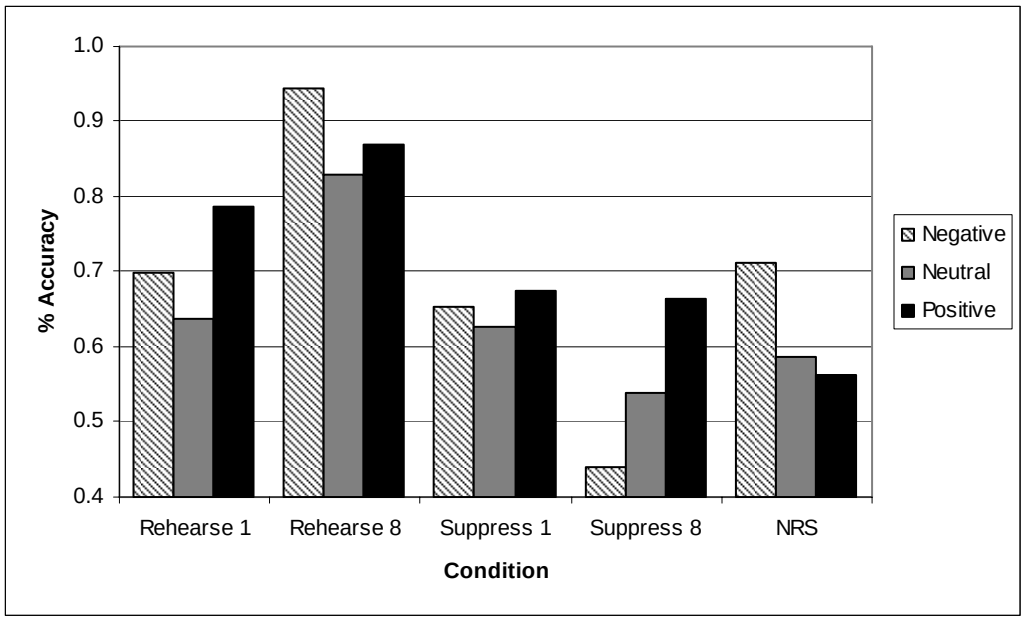

Figure 3. Percent trials accurately identified as "old" on the final test, as a function of condition and valence of word in Experiment 2.

3.3 DISCUSSION

Individuals successfully suppressed faces in a similar manner to words or nonverbalizable shapes in certain situations, adding to the applicability of the TNT paradigm as a model of suppression that individuals might employ in everyday situations. There may be many times when individuals do not want to remember faces of individuals. That they can forget faces due to suppression in this experimental setting is an important step in understanding how individuals

deal with encountering others with whom they have negative associations. Despite overall success, however, the forgetting demonstrated was mitigated by valence. Not all cue valences were equal in their forgetting effects: successful forgetting was only seen consistently with negative cue words.

It is also important to consider that this experiment did not completely replicate the original findings of Anderson and Green (2001). There was not an overall inhibitory effect of items that were suppressed once as compared to NRS items. Likewise, in the condition that was most similar to Anderson and Green's research – the neutral condition – there was no significant difference between suppressed and NRS items. Thus, while we can conclude from these results that the original inhibitory findings do replicate in some conditions, including when we average all data, we cannot say with certainty that the results will always replicate, or that they are consistent across all conditions. Clearly, we need to more closely consider the conditions under which suppression will induce inhibition and when it will not.

Further, in the real world, there are often situations in which the cues for the information we want to forget are not neutral. It is therefore important to consider how individuals respond to trying to suppress when the cues that cause them to remember information are emotional, a research area that thus far appears to be lacking. The results of this experiment suggest that when a cue is positive or neutral, forgetting of suppressed items was not as great as NRS items. That is, suppressed items were remembered significantly better than NRS items, but not as well as rehearsed items. While this finding is similar to previous research (Anderson and Green, 2001), this finding does not demonstrate the increased inhibitory finding for suppressed items over NRS items that is commonly discussed. When the cue was negative, however, items that were suppressed were less accessible than even items that were never shown during the second phase. That is, suppressed items were recognized less often than NRS items. The finding involving negative cues was more in line with the previous TNT results.

There are a number of possible causes of the negative cue pattern of results. One potential explanation is that individuals may simply be more experienced at suppressing cues to information when those cues are negative. Individuals with negative experiences are not always likely to have those memories cued by positive or even neutral cues. In many cases, they are much more likely instead to think about a memory they are trying to avoid by a negative cue.

This is especially true in a situation that would mirror a recognition memory test, where the cue to think about a target is the target itself (or something similar).

Another possibility is that positive or neutral cue information is easier to stop attending to than negative cue information. Thus, the associated face would be expected to be easier to start thinking about when associated with positive or neutral cues. Put another way, it is harder to suppress items associated with positive or neutral cues because it is easier to finish processing the positive or negative cue information and move on to another task. The use of negative cues may make it easier for individuals to continue attending to the cue than to think of the associated face because they may have a harder time stopping themselves from thinking about the negative cue.

4.0 EXPERIMENT 3

It now appears evident that, to varying degrees, it is possible to forget neutral memories when given emotional cues. Still unclear is the importance of valence of the target being suppressed on forgetting. If a battered wife can suppress thinking about her abuser upon seeing a belt (an item used to hit her), is that because she is thinking of him when he was nice (suppressing a positive target) or not doing anything at all (suppressing a neutral target), or is she actually suppressing thinking about how he was when he was angry or violent (suppressing a negative target)? What if she can only think of him in one emotional state (i.e., only when he is happy, angry, asleep, etc.)?

In order to again expand our understanding of the TNT paradigm, we will now consider the effects of the emotional content of the face. Here again we are faced with the possibility that there is something inherently different between positive, neutral, and negative target stimuli as regards forgetting ability. If we process emotional and unemotional memories similarly, we should expect both to show similar patterns of forgetting. If emotional memories are accessed differently, however, we must consider the reasons for that differential memory ability. Potentially, differences in memory ability could be due to how individuals process information. However, those differences may also be due to reasons related to other factors, such as differential experience suppressing or motivation.

Intentional forgetting and retrieval-induced forgetting experiments have demonstrated that individuals can forget positive, neutral, and negative information, though, as mentioned earlier, different researchers tends to equivocate on the effect of valence on forgetting. As discussed previously, research has alternately shown that forgetting is easier for positive stimuli or negative stimuli (e.g., Amir, et al., 2001; Barnier, et al., 2004; Wessel and Wright, 2004), and no meta-analysis has been done at this time to consider differences in those research designs and findings.

Experiment 3 considers valence of target face, given a neutral cue word. While it is relevant to know that emotional cues can have an effect on neutral memories, understanding whether we can forget emotional memories allows us to consider other situations of forgetting, where the target memory cannot in any way be construed as neutral. In Experiment 2, the target faces were neutral while cue words varied by valence. In Experiment 3, the target faces are emotional and the cue words are neutral.

4.1 METHODS

4.1.1 Participants and design

Forty-two participants from the Fairfield, CT and Amherst, MA areas volunteered for this 3 (not presented, presented once, or presented eight times in phase two) x 2 (rehearsed or suppressed) x 3 (positive, neutral, or negative face).

4.1.2 Materials and procedure

Experiment 3 replicated the procedure in Experiment 2, with the following changes: First, participants learned to pair 36 neutral words drawn from the ANEW list (Bradley and Lang, 1999) and 36 faces (12 positive, 12 negative, and 12 neutral) designed by Faces 3.0. In addition to the 36 target faces, there were 36 foils for the final test phase and 36 fillers for the learning and TNT phases. The target faces were not used in Experiment 2, but some of the neutral words were drawn from Experiment 1. The method of designing the faces was similar to that of Experiment 2, with special attention paid to mouths, eyes, and eyebrows. Both targets and foils were again equally likely to be male or female and African-American or Caucasian. Targets and foils shared similar features, though each face was unique and no feature was used more than four times. Those faces were selected as positive (e.g., happy, surprised), neutral (e.g., bored, sleepy), or negative (e.g., angry, sad) based on facial expressions. Three independent judges

scored each face for valence, with a high overall interrater reliability, W = .829. Finally, in the Final Test phase, participants were given a recognition test on 72, instead of 100, faces.

4.2 RESULTS

4.2.1 Recognition accuracy: Condition

An ANOVA considering accuracy of old/new judgments showed significant differences between conditions for action during TNT phase and an interaction between TNT phase and number of repetitions, F (2, 82) = 70.948, $p < .001$, and F (2, 82) = 55.312, $p < .001$, respectively.

Overall, rehearsed faces were more likely to be correctly identified as "old" than suppressed or NRS faces, t (41) = 11.767, $p < .001$ and t (41) = 9.626, $p < .001$, respectively. While there was no significant main effect for repetitions, $p < .10$, R1 faces were significantly more likely to be recognized as old than S1 faces, t (41) = 5.669, $p < .001$. Additionally, R8 faces were significantly more likely to be accurately judged as old than R1 faces, t (41) = 6.122, $p < .001$, while there was only a trend showing lowered accessibility for S8 faces as compared to S1 faces, t (41) = 1.776, $p = .083$. There was no difference between suppressed and NRS faces, $t < 1$, $p > .10$. Thus, when confronted with the word, participants were more likely to forget faces if they attempted suppression instead of rehearsal. However, participants were not more likely to forget faces when they suppressed those faces when compared with uncued faces. Finally, NRS items were significantly more accurately remembered than chance, t (41) = 18.850, $p < .001$. (See Figure 4.)

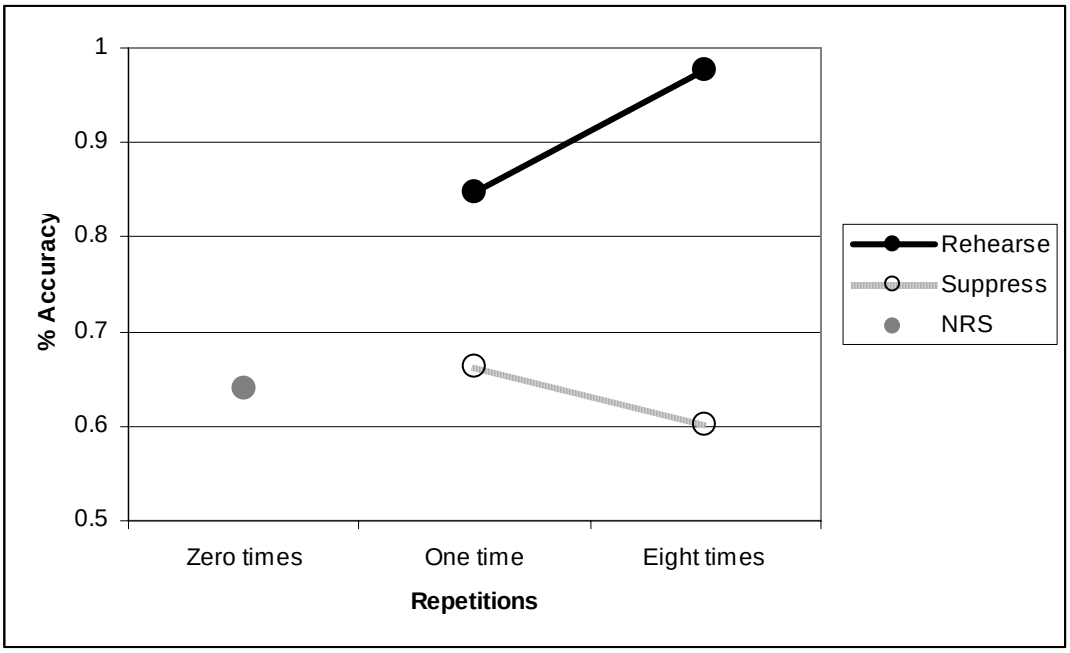

Figure 4. Percent of trials accurately identified as "old" on the final test, as a function of condition in Experiment 3.

4.2.2 Recognition accuracy: Valence of response face

An ANOVA of the effect of the valence of the face on accurate recognition showed a main effect for valence, as well as an interaction between valence and condition, F (2, 82) = 7.455, p = .001 and F (4, 164) = 14.039, p < .001, respectively.

When considering the effect of valence, participants were less accurate with positive faces than with negative faces, t (41) = 4.104, p < .001. The pattern of inhibition changed based on the valence of the face. When positive, rehearsed faces were more accurately identified than either suppressed or NRS faces, t (41) = 5.579, p < .001 and t (41) = 7.688, p < .001, respectively, and suppressed faces were more accurately remembered than NRS faces, t (41) = 2.279, p = 028. Thus, when reacting to a positive face, rehearsed faces were best recognized, followed by suppressed faces, and then NRS faces. Finally, positive NRS items were significantly more accurate than chance, t (41) = .120, p > .01.

When neutral, rehearsed items were more accurately identified than either suppressed or NRS faces, t (41) = 8.900, p < .001 and t (41) = 6.058, p < .001, respectively. There was no significant difference between suppressed and NRS faces, t < 1, p > .10. Thus, when reacting to a

neutral face, rehearsed faces were best recognized, followed equally by NRS and suppressed faces. Finally, neutral NRS items were significantly more accurately remembered than chance, t (41) = 17.973, $p < .001$.

When negative, rehearsed faces were more accurately recognized than either suppressed or NRS items, t (41) = 8.207, $p < .001$ and t (41) = 3.901, $p < .001$, respectively, and NRS faces were more accurately recognized than suppressed faces, t (41) = 3.054, $p = .004$. Therefore, when reacting to a negative face, participants recognized rehearsed faces best, followed by NRS, and then suppressed faces. (See Figure 5.) Finally, all NRS items were significantly more accurately remembered than chance, no matter the valence (negative: t (41) = 28.830, $p < .001$; neutral: t (41) = 5.818, $p < .001$; positive: t (41) = 3.236, $p < .001$).

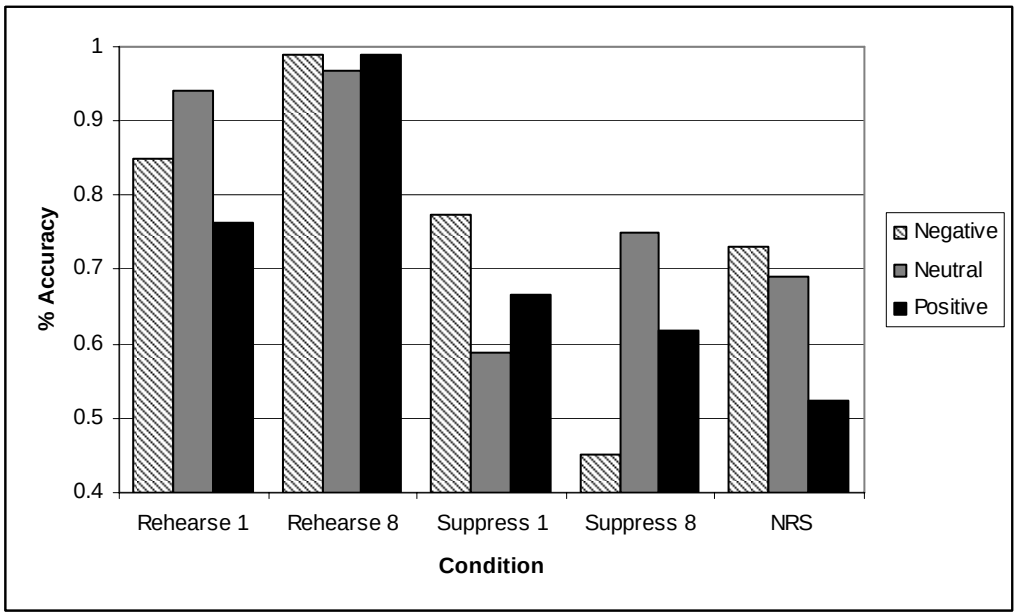

Figure 5. Percent trials accurately identified as "old" on the final test, as a function of condition and valence of face in Experiment 3.

4.3 DISCUSSION

The present research has demonstrated a replication of the inhibitory effects previously seen with neutral target information (words, shapes, and faces), differentially based on valence of the target face. Previous stimuli sets have involved targets that were neutral. In the present experiment, the

faces had an emotional quality to them, allowing for us to consider whether trying to suppress a target that is positive, neutral, or negative changes the overall ability to suppress. What we find is that suppression is still possible, but that valence again mediates the effectiveness of the inhibition (this time, the valence of the target).

The findings from Experiment 3 demonstrate that when the target information is positive, suppression appears to increase memory, such that mere exposure is beneficial, compared to no exposure at all. This result, while similar to the findings for positive cue information, does not fully replicate the original research of Anderson and Green (2001). Whereas Anderson found that suppression resulted in memory inhibition, the present research demonstrated that there are mitigating factors affecting the ability to forget information through suppression. With neutral associated information, mere exposure with the intent to suppress minimizes memory to the point of no exposure, not improving memory, but not inhibiting it either. Again, while similar to the finding for when the cue was neutral, and slightly closer to the original inhibition finding, this result is not an exact replication of Anderson's overall findings of suppression causing memory accuracy below no exposure to cues. Finally, for negative associated responses, the act of suppression does indeed cause reduced memory, as measured by less accuracy at recognition memory, as compared to rehearsal. Here, as was the case when the cue was negative, we find a replication of the research by Anderson and Green's TNT results.

I propose two possible explanations for these findings. First, individuals may be differentially experienced in suppressing negative and, to a lesser degree, neutral information than positive information. This would be the case if we assume that individuals do not suppress positive experiences as much as other experiences, and suppress negative experiences the most. This seems to be a strong possibility, when we consider the situations in which we expect individuals to suppress. Whereas there are times when individuals would try to suppress positive or neutral information (such as avoiding thinking of something because it is distracting), there are probably far more times when individuals would suppress negative information (such as when the information causes emotional pain). Thus, they are becoming more experienced in the act of suppression.

Second, the ability to suppress may vary due to feelings of aversion to the target information: Perhaps individuals are more willing to suppress negative thoughts or memories because they are specifically motivated by aversion. This could lead individuals to be more

likely to either succeed, which speaks to skill, or at least try, which speaks to motivation. The skill explanation was discussed earlier. For the motivation explanation, it may be that individuals are better at suppressing negative information because they are more motivated to do so. If individuals feel an aversion to the information that they are trying to suppress, they may try harder to suppress. For positive information, individuals may not be as motivated to suppress, and less effort will lead to less success. For negative information, individuals may feel more motivated to suppress due to an aversion to the target information. For neutral information, the level of aversiveness can vary, though that information will not be extremely negative.

The finding that suppression increases forgetting rates over baseline only for negative target items is important to the real-life applicability of the TNT paradigm. If individuals are attempting to avoid thinking about something that is neutral, they will be about as successful as if they are not forced into contact with cues to think about the neutral stimuli. Thus, the previous inhibitory effects seen by Anderson do not appear to replicate to the same degree in the present experiment. Again, however, it is important to consider that Anderson was not always able to replicate his own inhibitory effects consistently (Anderson and Green, 2001). These findings can be seen as even stronger than the original research.

5.0 GENERAL DISCUSSION

We know that when people suppress information, their memories are less accurate, and in some cases, the forgetting caused by suppression increases with additional suppression attempts (Anderson and Green, 2001). In contrast, increased rehearsal results in increased accuracy in memory. Research with the TNT paradigm has thus far addressed this forgetting only in terms of words, and then only with recall tests.

Our understanding about forgetting either of emotional stimuli or using recognition tests is derived from intentional forgetting and retrieval-induced forgetting research. Both literatures have indicated that emotional information is possible to forget, though they equivocate on whether positive or negative information is easier to forget. Intentional forgetting and retrieval-induced forgetting researchers do agree, however, that suppression does cause forgetting, to varying degrees, in recognition tests.

5.1 CURRENT FINDINGS

We can think of suppression in two ways. First, it can cause *absolute* forgetting, where recognition of suppressed items is poorer than that for items that were neither rehearsed nor suppressed (NRS items). Second, suppression can cause *relative* forgetting, where recognition is less accurate for suppressed information than for rehearsed information, but greater than that for the NRS items. In some situations, forgetting due to suppression was absolute (for instance, situations when the cue or target is negative); in all conditions, however, the forgetting was at least relative. Each of these situations is discussed below.

5.1.1 Recognition memory

In all three experiments, recognition memory was tested. Each time, participants showed some degree of forgetting on a recognition test, a finding similar to previous TNT research using recall tests. Overall, the expected forgetting findings (participants had a harder time remembering information that they suppressed than information that they did not suppress) were observed in each experiment. In addition to observing forgetting in each of the individual experiments, when we consider all three experiments together, the data again produce a pattern of absolute forgetting due to suppression. (See Figure 6.) While not as readily remembered as when tested using a free recall test, the pattern of results remains the same. While this may seem inconsistent with previous findings considering recognition and recall tests (that information is easier to access using recognition tests), it is important to remember that the present experiments use different types of stimuli, nonvervalizable shapes and faces, than Anderson and Green (2001), who used words. Additionally, the present stimuli are not easily tested using recall testing.

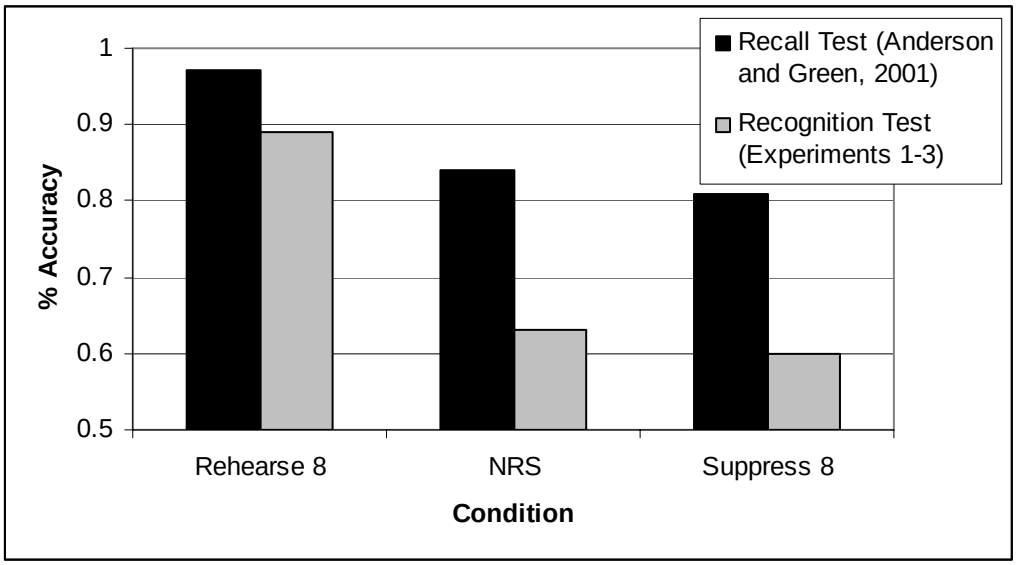

Figure 6. Percent trials accurately recognized as "old" across all three experiments, compared to recall memory results from Anderson and Green, 2001.

Recognition tests provide a powerful cue to remember the target. Given that participants saw "old" targets in a recognition test and still misidentified those targets as "new" demonstrates that, at the very least, participants now have less confidence in their memories. That is, since their certainty that they *have* seen a target is lower if they have suppressed it compared to if they

have not suppressed it, participants are less likely to agree that they had seen a target following suppression. While this may not mean that participants have completely forgotten the target, it does mean that they are less certain that they have seen the target, and may even have the explicit memory or belief that they had not previously seen the target. This appears to align the TNT paradigm with intentional forgetting and retrieval-induced forgetting research. Those literatures have also demonstrated that recognition tests are fairly consistent with recall memory tests (Anderson, et al., 2000; Hicks and Starns, 2004; Sahakyan, 2004).

5.1.2 Visual stimuli

Various types of visual stimuli were used in all three experiments. The first experiment involved nonverbalizable shapes. It was important to consider these shapes due to their non-lexical nature. While not necessarily as complex as words, nonverbalizable shapes allow for participants to focus almost entirely on the visual quality of the stimuli (i.e., considering information from only one modality). In addition, the use of shapes allowed for the learning of entirely novel information, extending the applicability of the TNT paradigm.

Experiments 2 and 3 utilized faces. The use of these faces allowed for a better understanding of forgetting of more ecologically valid stimuli, as well as more complex and engaging stimuli. The everyday significance of data regarding faces is perhaps the most striking of all applications, however. There are many situations in which we might imagine a person attempting to suppress a face instead of a shape or word. That it is possible to forget faces through suppression adds to the credibility of suppression as a viable explanation for forgetting in social situations where the target that we are trying to forget is often an individual.

In Experiment 1, participants demonstrated absolute forgetting when suppressing simple visual stimuli. In Experiments 2 and 3, participants demonstrated absolute and relative forgetting of faces. While the degree to which forgetting was possible with faces varied, that variance was likely not related to the fact that the stimuli were faces. In both Experiments 2 and 3, when data were collapsed across valence conditions, the results produced the expected absolute forgetting finding predicted by Anderson and Green's original findings. That people are able to suppress visual stimuli extends previous research from intentional forgetting and retrieval-induced

forgetting literatures that also seems to demonstrate that the use of visual stimuli is not a limitation on the ability to forget through suppression (Ford, et al., 1995; Lehman, et al., 1998).

Finally, we must also pay attention to the differences in information we can draw from forgetting of faces as compared with shapes. Nonverbal shapes are beneficial in that they allow for a bridge between previous research (solely lexical stimuli) and the present research (visual stimuli). However, that we do not see significant neutral findings for face/word pairs and do for shape/word pairs does lead one to consider the possibility that there is something intrinsically different about faces and other types of stimuli. Without specifically considering neutral words paired with neutral faces, we cannot definitively differentiate the effect of neutral words and faces as compared to neutral words and shapes.

5.1.3 Emotional stimuli

Experiments 2 and 3 addressed valence of the cues and targets, respectively, when attempting suppression. When we average these findings across experiments, the findings again remain the same: When either the target or cue was positive, suppression resulted in only relative forgetting. When the target or cue was negative, suppression resulted in absolute forgetting. (See Figure 7.) Specifically, in Experiment 2, suppression resulted in absolute forgetting of neutral targets for negative cues, but relative forgetting from positive and neutral cues. Experiment 3 mirrored these results, but with neutral cues and varying the valence of the target.

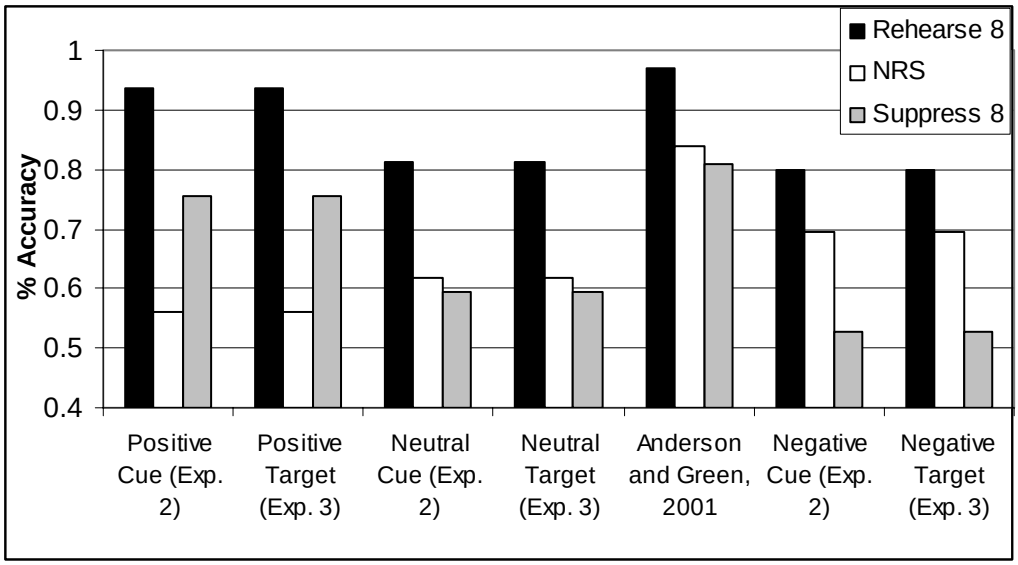

Figure 7. Percent trials accurately identified as "old" on the final test, as a function of condition and valence across experiments 2, 3, and Anderson and Green's neutral cue and target results (2001).

There are a number of ways to consider the relevance of this finding. First, we are more likely to have a greater need to suppress negative information as opposed to neutral or positive information. This could mean that individuals are better at suppressing negative information because it serves as a successful coping mechanism intended for negative information (i.e., suppression is naturally designed for negative information). Alternately, this may also mean that individuals are more likely to suppress negative stimuli than neutral or positive information, and so are better at it because they do it more (i.e., individuals become skilled at suppressing negative information due to greater relative use compared to neutral or positive information). The directionality of the relationship between suppression success and negative information is unclear, but it is conceptually an important one.

If Anderson and Green (2001) were correct in postulating that the TNT paradigm could explain how people forget traumatic experiences, then that could lead us to predict that suppression should be especially effective for negative cues and stimuli. Given that traumatic experiences are often triggered (relevant to the findings of Experiment 2) by negative cues, and traumatic experiences (relevant to the findings of Experiment 3) are, by definition, negative, the data that negative cues and responses can be suppressed are consistent with Anderson and Green's expectation. Specifically, the present results demonstrate that suppression will be most successful if the cue and target are negative.

Finally, it may be that we are more biologically more predisposed to successfully suppressing negative information, as opposed to positive information. Just as certain associations are more easily made than others (e.g., touching something that results in a shock will require fewer training sessions than eating something that results in a shock) (Garcia and Koelling, 1966), so too may certain kinds of information be easier to suppress. If this is the case, we should see a similar pattern of negative information being better suppressed than positive information in intentional forgetting and retrieval-induced forgetting research as well. While this finding is not is not always found, it does appear often enough for us to question if there are specific circumstances in which this is likely to be consistently found (e.g., special populations, traumatic memories, etc.).

5.2 USING THE TNT TO EXPLAIN CURRENT PHENOMENA

There are a number of ways in which the TNT findings have been used to describe normal human memory processing. I will detail below two such situations: continuing social interactions with people with whom we have had negative encounters, and the forgetting step of repression.

5.2.1 Social interactions

In interpersonal relationships, we can, and often do, choose to exclude information from our environments that we know trigger us to think about unwanted memories. After we separate from a spouse or lover, we will often remove pictures of that individual from our immediate surroundings. Without those cues in our immediate environment, we often find that we are better able to cope with and avoid unwanted memories and thoughts. Sometimes, however, it is not possible to remove those cues. If we continue to work with a former spouse, for example, it is not feasible to remove all cues of that person from our environment. Therefore, when we are not able to remove cues, the present research can inform us of those times when suppression is likely to be most helpful, in lieu of removal of cues.

The present research is especially telling for social situations. First, there are situations in which suppression will be effective when there is no escaping the cues in one's environment. In those situations, it is not possible to remove cues to think about a target, but forgetting will be more successful when one suppresses the target, as opposed to allowing oneself to think about the target (relative forgetting, as tested when comparing rehearsed and suppressed targets). Additionally, there are specific times when removal of the cues to remember a target (having no cues to think about the target, as tested using the NRS condition) is not as effective as intentional suppression. When trying to suppress negative thoughts, for instance, the use of suppression actually appears to cause fuller forgetting than not presenting the cues to remember at all (absolute forgetting).

5.2.2 Forgetting step of repression

The TNT paradigm has evoked considerable excitement and controversy due to speculation that it may provide the foundation for a laboratory analogue to the processes associated with the forgetting aspects of "repression" (e.g., Conway, 2001; Kihlstrom, 2002; Levy and Anderson, 2002; Schacter, 2001), although clearly, great caution must be taken in overgeneralizing the results of this TNT manipulation. The TNT paradigm produces only modest differences in memory for relatively benign stimuli, whereas "repression" may result in the extensive forgetting of highly emotional material (e.g., Wilsnack, Wonderlich, Kristjanson, Vogeltanz-Holm, and Wilsnack, 2002)[4]. However, we can begin to consider this issue on a conceptual level.

In the ongoing debate about the validity of claims of repression, researchers differ in their notions regarding how individuals might come to forget and then later remember information. Some have claimed that the TNT paradigm offers a new glimpse into how we might suppress traumatic information, such that the recollection of that information, as well as the knowledge that it was previously unavailable, would lead to reporting the phenomenon as repression (Anderson, Ochsner, Kuhl, Cooper, Robertson, Gabrieli, Glover, and Gabrieli, 2004; but cf. Kihlstrom, 2002). According to this view, individuals who experience trauma are often confronted with cues that stimulate them to think about that trauma. In order to avoid accessing those traumatic memories, individuals redirect their thoughts when confronted with cues to avoid thinking about the trauma – analogous to the suppression condition of the TNT paradigm.

The TNT paradigm has been referenced as a potential explanation for how traumatic memories might be forgotten. The present research adds to our understanding of that application by allowing us to consider the individual variables which might influence the efficacy of the forgetting caused by suppression in the TNT paradigm. For instance, if we are to eventually begin to draw parallels between the TNT paradigm and reported repressed memories of

[4] Indeed, it sometimes seems difficult to believe that consensus will ever be reached regarding whether a well-specified laboratory phenomenon might provide a foundation for a construct that is so ambiguously defined and inconsistently used as "repression" (Schooler, et al., 1996). Notably, the term repression is at times used to denote the phenomenon of total forgetting of traumatic material (e.g. Ofshe and Singer, 1994), at other times to describe an entirely non-conscious psychodynamic mechanism (e.g., Conway, 2001), and at still other times to refer to a more deliberate suppression mechanism (e.g., Erdelyi, 2001).

traumatic experiences, it is important for us to know that the forgetting observed in the TNT paradigm is driven by negative stimuli. Indeed, were it not relevant for negative stimuli, it would be difficult to draw a parallel between the laboratory procedure of the TNT paradigm and real world forgetting situations. Similarly, to know that the procedure is not limited to word forms allows us the freedom to continue to explore the outer limitations of the forgetting of the TNT paradigm and how it can speak to forgetting in everyday life.

5.3 POTENTIAL APPLICATIONS OF THE TNT PARADIGM

There are a number of clinical applications for this research. For example, cues triggering flashbacks are a hallmark of post-traumatic stress disorder (PTSD). With PTSD, it is often a seemingly neutral cue that causes individuals to remember a negative memory. Though not as dramatic as PTSD, people experiencing specific phobias will remember negative memories in response to often innocuous cues.

The present research offers insights into situations in which it might be beneficial to engage in suppression. In the course of coping with PTSD and phobias, this research may allow a better understanding of applying suppression to aid in the elimination of negative responses to cues. Perhaps in combination with other behavioral or physiological therapies, the present research may become a part of a successful clinical treatment to overcome emotional cues or avoid emotional target thoughts and memories. The insight from this research informs us as to situations in which suppression might be most successful.

5.4 RESEARCH EXTENSIONS

The original impetus for the TNT paradigm was to better understand the phenomenon of people reporting that they experienced events for which they previously had no memory. An example of one such event might be a recovered memory of abuse. While this paradigm does not demonstrate that people can later come to remember information that they did not have access to

(suppression recovery), it is a first step in demonstrating that it is possible, through ordinary memory processes, to intentionally suppress an event that one may want to forget.

One next logical step, then, is to consider the circumstances under which it might be possible to recover forgotten suppressed information after long delays. Various methods could be employed to accomplish this. One way could be to reteach all of the information, as well as new information, and compare the learning curve for each. If there is still an effect of the previously learned information, we should expect the learning curve for the old information to be faster than for the new information, as well as faster than for its own initial learning curve.

Another method might be to tell participants that they did formerly learn information, and then ask them how much of that information they remember. In this research, we could compare reported memory for four types of information: information that participants did not learn but are told that they did learn (information that is new but they are mislead to think is old), information that participants did learn and are told that they did not learn (information, both rehearsed and suppressed, that is old and participants are mislead to believe is new), information that participants did not learn and are not told that they did learn (information that participants are not mislead to believe is new), and information that participants did learn and are not told that they did learn (information, both rehearsed and suppressed, that is old and that participants are not mislead to believe is new). If there are vestiges of the old information still lingering, there should be at least a heightened feeling of familiarity of the old information, whereas there might be less familiarity with new information that participants are told they already knew.

With the present research, there was no personal connection between the stimuli and the participant. That is, the shapes and faces shown were not images that participants knew or had any reason to suppress. In that lack of personal relationship to the stimuli, we are forced to generalize about how people will respond to the stimuli, but not necessarily self-relevant stimuli. In the future, it would be important to consider the effect of a personal connection to the stimuli in terms of a person's ability to suppress. If one is not able to suppress self-relevant information, then the TNT paradigm has limited effectiveness in terms of explaining how people might exert voluntary control over their thoughts and memories.

Another point to consider is that, in real life situations, it is often the case that both the cues and targets are emotional. In the experiments described here, the cues or targets could be emotional, but never both. If we include trials where both the cue and the target are emotional

stimuli, we should be more accurate in reflecting real situations that people face when attempting to suppress information. Doing so would add to the credibility of the theory underlying the TNT paradigm: that short-term intentional suppression can reduce memory in situations in which people would want to limit accessibility. Additionally, it would be interesting to consider the effect of varying the valence of both the cue and the target, both to look for an interaction and to see which is more powerful in driving the forgetting effects. Said another way, which is more important: the valence of the cue or the valence of the target?

Finally, it will be important to consider the effect of arousal on memory. If a stimulus cue or item to-be-remembered is highly arousing, it may be that it will have a negative effect on the ability to inhibit. On the other hand, if people are more skilled in suppressing highly arousing information, they may be better at suppressing arousing information than unarousing information.

5.5 FINAL THOUGHTS

The TNT paradigm is more generally applicable to situations outside of word list learning tasks, and is very useful for informing us about the importance of valence of cues and memories, and how they affect performance. All of this supports our use of the TNT paradigm for understanding a powerful phenomenon: forgetting due to intentional suppression within a normal memory context. This research illustrates that forgetting of emotional information is not necessarily something that is untestable, relying on concepts we have yet to reliably define, much less empirically assess. In addition, were the TNT paradigm to be developed further, it may allow us the opportunity to improve an individual's coping skills, and help them overcome symptoms associated with affectively negative memories.

BIBLIOGRAPHY

Amir, N., Coles, M.E., Brigidi, B., & Foa, E.B. (2001). The effect of practice on recall of emotional information in individuals with generalized social phobia. *Journal of Abnormal Psychology, 110,* 76-82.

Anderson, M.C., & Bell, T. (2001). Forgetting our facts: The role of inhibitory processes in the loss of propositional knowledge. *Journal of Experimental Psychology: General, 130,* 544-570.

Anderson, M.C., Bjork, E.L., & Bjork, R.A. (2000). Retrieval-induced forgetting: Evidence for a recall-specific mechanism. *Psychonomic Bulletin and Review, 7,* 522-530.

Anderson, M.C., Bjork, R.A., & Bjork, E.L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 1063-1087.

Anderson, M.C. & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature, 410,* 366-369.

Anderson, M.C., Ochsner, K.N., Kuhl, B., Cooper, J., Robertson, E., Gabrieli, S.W., Glover, G.H., Gabrieli, J.D.E. (2004). Neural systems underlying the suppression of unwanted memories. *Science, 303,* 232-235.

Attneave, F. & Arnoult, M.D. (1957). A quantitative study of shape and pattern perception. *Psychological Bulletin, 53,* 452-471.

Barnier, A.J., Hung, L., & Conway, M.A. (2004). Retrieval-induced forgetting of emotional and unemotional autobiographical memories. *Cognition and Emotion, 18,* 457-477.

Basden, B.H. & Basden, D.R. (1998). Directed forgetting: A contrast of methods and interpretations. In J. M. Golding and C. M. MacLeod (Eds.) *Intentional Forgetting: Interdisciplinary Approaches.* Lawrence Erlbaum Publishers, pp. 139-172.

Bjork, E.L. & Bjork, R.A. (2003). Intentional forgetting can increase, not decrease, residual influences of to-be-forgotten information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29,* 524-531.

Bradley, M.M. & Lang, P.J. (1999). *Affective norms for English words: Instructional manual and affective ratings*. Technical Report C-1, The Center for Research in Psychophysiology, University of Florida.

Bruce, V. & Young, A. (1986). Understanding face recognition. *British Journal of Psychology, 77*, 305-327.

Bylin, S. & Christianson, S. (2002). Characteristics of malingered amnesia: Consequences of withholding vs. distorting information on later memory of a crime event. *Legal and Criminological Psychology, 7*, 45-61.

Ciranni, M.A. & Shimamura, A.P. (1999). Retrieval-induced forgetting in episodic memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 1403-1414.

Cohen, M.E. & Nodine, C.F. (1978). Memory processes in facial recognition and recall. *Bulletin of the Psychonomic Society, 12,* 317-319.

Collins, A.M. & Loftus, E.F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82,* 407-428.

Conway, M.A. (2001). Cognitive neuroscience – Repression revisited. *Nature, 410,* 320-319.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58,* 17-22.

Erdelyi, M.H. (2001). Defense processes can be conscious or unconscious. *American Psychologist, 56,* 761-762.

Fallshore, M. & Schooler, J.W. (1995). Verbal vulnerability of perceptual expertise. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 1608-1623.

Fleck, D.E., Berch, D.B., & Shear, P.K. (2001). Directed forgetting in explicit and implicit memory: The role of encoding and retrieval mechanisms. *Psychological Record, 51,* 207-221.

Ford, R.M., Keating, S., & Patel, R. (2004). Retrieval-induced forgetting: A developmental study. *British Journal of Developmental Psychology, 22*, 585-603.

Foster, R.N. & Gavelek, J.R. (1983). Development of intentional forgetting in normal and reading-delayed children. *Journal of Educational Psychology, 75,* 431-440.

Garcia, J. & Koelling, R.A. (1966). The relation of the cue to consequence in avoidance learning. *Psychonomic Science, 4,* 123-124.

Garry, M., & Loftus, E.F. (2004). I am Freud's brain. *Skeptical Enquirer, 28(3),* 16-18.

Gauthier, I., Curran, T., Curby, K.M., & Collins, D. (2003). Perceptual interference supports a non-modular account of face processing. *Nature Neuroscience, 6,* 428-432.

George, N., Dolan, R.J., Fink, G.R., Baylis, G.C., Russell, C., & Driver, J. (1999). Contrast polarity and face recognition in the human fusiform gyrus. *Nature Neuroscience, 2,* 574-580.

Hayes, S.C., & Bissett, R.T. (1998). Derived stimulus relations produce mediated and episodic priming. *Psychological Record, 48,* 617-630.

Hedden, T. & Park, D.C. (2003). Contributions of source and inhibitory mechanisms to age-related retroactive interference in verbal working memory. *Journal of Experimental Psychology: General, 132,* 93-112.

Hicks, J.L. & Starns, J.J. (2004). Retrieval-induced forgetting occurs in tests of item recognition. *Psychonomic Bulletin and Review, 11,* 125-130.

Kihlstrom, J.F. (2002). No need for repression. *Trends in Cognitive Science, 6,* 502.

Lehman, E.B., Morath, R., & Franklin, K. (1998). Knowing what to remember and forget: A developmental study of cue memory in intentional forgetting. *Memory and Cognition, 26,* 860-868.

Levy, B.J., & Anderson, M.C. (2002). Inhibitory processes and the control of memory retrieval. *Trends in Cognitive Science, 6,* 299-305.

McCarthy, G., Puce, A., Gore, J.C., & Allison, T. (1997). Face-specific processing in the human fusiform gyrus. *Journal of Cognitive Neuroscience, 9,* 605-610.

McNally, R.J., Clancy, S.A., & Barrett, H.M. (2004). Inhibiting retrieval of trauma cues in adults reporting histories of childhood sexual abuse. *Cognition and Emotion, 18,* 479-493.

Muther, S.W. (1965). Erasure or partitioning in short-term memory. *Psychonomic Science, 3,* 429-430.

Myers, L.B., Brewin, C.R., & Power, M.J. (1998). Repressive coping and the directed forgetting of emotional material. *Journal of Abnormal Psychology, 107,* 141-148.

Ofshe, R.J. & Singer, M.T. (1994). Recovered memory therapy and robust repression: Influence and pseudo-memories. *International Journal of Clinical and Experimental Hypnosis, 42,* 391-410.

Pellicano, E. & Rhodes, G. (2003). Holistic processing of faces in preschool children and adults. *Psychological Science, 14,* 618-622.

Sahakyan, L. (2004). Destructive effects of "forget" instructions. *Psychonomic Bulletin & Review, 11,* 555-559.

Schacter, D.L. (2001). Suppression of unwanted memories: Repression revisited? *Lancet, 357,* 1724-1725.

Schooler, J.W., Bendiksen, M., & Ambadar, Z. (1997). Taking the middle line: Can we accommodate both fabricated and recovered memories of sexual abuse. In M.A. Conway (Ed.), *False and recovered memories,* 251-292. Oxford: Oxford University Press.

Shaw, J.S., Bjork, R.A., & Handal, A. (1995). Retrieval-induced forgetting in an eyewitness-memory paradigm. *Psychonomic Bulletin & Review, 2,* 249-253.

Smith, R.E. & Hunt, R.R. (2000). The influence of distinctive processing on retrieval-induced forgetting. *Memory and Cognition, 28,* 503-508.

Smith, S.M., Gleaves, D.H. Pierce, B.H. (2003). Eliciting and comparing false and recovered memories: An experimental approach. *Applied Cognitive Psychology, 17,* 251-279.

Tekcan, A.I. & Aktürk, M. (2001). Are you sure you forgot? Feeling of knowing in directed forgetting. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 27,* 1487-1490.

Veling, H. & van Knippenberg, A. (2004). Remembering can cause inhibition: Retrieval-induced inhibition as cue independent process. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30,* 315-318.

Wallace, W.P. & Page, K.A. (1982). Recognition tests trials without distractors: A comparison of trials and study trials on recognition and recall. *Bulletin of the Psychonomic Society, 20,* 245-248.

Wessel, I. & Wright, D.B. (2004). Emotional memory failures: On forgetting and reconstructing emotional experiences. *Cognition and Emotion, 18,* 449-455.

Whetstone, T., Cross, M.D., & Whetstone, L.M. (1996). Inhibition, contextual segregation, and subject strategies in list method directed forgetting. *Consciousness and Cognition: An International Journal, 5,* 395-417.

Williams, L.M. (1995). Recovered memories of abuse in women with documented child sexual victimization histories. *Journal of Traumatic Stress, 8,* 649-673.

Wilsnack, S.C., Wonderlich, S.A., Krisjanson, A.F., Vogeltanz-Holm, N.D., & Wilsnack, R.W. (2002). Self-reports of forgetting and remembering childhood sexual abuse in a nationally representative sample of US women. *Child Abuse and Neglect, 26,* 139-147.

Windmann, S., Urbach, T.P., & Kutas, M. (2002). Cognitive and neural mechanisms of decision biases in recognition memory. *Cerebral Cortex, 12,* 808-817.

Woodward, E.A. & Bjork, R.A. (1971). Forgetting and remembering in free recall: Intentional and unintentional. *Journal of Experimental Psychology, 89,* 109-116.