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Exploring Intentional Forgetting:

Using novel Think/No-think paradigms to investigate memory
suppression.

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Abstract

Individual differences in thought suppression are explored in three separate, but related, research efforts. A survey study generated novel insight into the relationship between personality traits and personal beliefs regarding thought suppression, and four separate novel Think/No-think paradigms were used to explore relationships between laboratory measures of memory suppression and personality traits.

The survey study utilized a novel inventory, the *Retrospective-Prospicive Suppression Inventory*, to determine individual beliefs regarding use of thought suppression in everyday life. Personality traits that have been implicated in the efficacy of laboratory thought suppression were measured and compared between participants who varied in self-reported thought suppression tendencies and efficacy. Individuals who reported engaging in successful suppression in everyday life were less neurotic, ruminative, and experienced fewer intrusive thoughts than individuals who reported unsuccessful suppressive attempts. The findings suggests that the high-ends of the neuroticism and intrusive thought spectra are occupied by individuals who unsuccessfully attempt everyday suppression, while successful suppressors differ minimally from individuals who report avoiding suppression in everyday life.

In two experiments memory for contextual information associated with items that were rehearsed or suppressed was examined, using two novel paradigms. Experiment 1 found participants generally unable to suppress items situated within a matrix of 9 items, and that contextual information associated with the items was recalled with great difficulty regardless of suppression or rehearsal. The design of Experiment 1 was then simplified from using a matrix of 9 items, to using sets of 3 items (i.e., item triads) for Experiment 2. Experiment 2 found participants generally unable to suppress items situated within item-triads, and contextual information remained unaffected by suppression and rehearsal.

In two experiments the imagined-event Think/No-think paradigm (iTNT) was used to test participant ability to suppress episodic information that was generated specifically for experimental purposes, and would thus be unlikely to have been previously rehearsed or suppressed. Individuals were able to suppress targets associated with emotionally negative imagined future events (Experiment 3), but were unable to suppress the gist recall of imagined past or future events (Experiment 4). A combined analysis revealed differences in suppressive capabilities between low, medium, and high neuroticism scores. Mid-neuroticism participants were readily able to suppress targets associated with emotionally negative imagined future events, but not imagined past events. High-neuroticism participants experienced a significant rebound effect for emotionally negative past events. Low-neuroticism participants were generally unable to suppress, but did not demonstrate significant rebound effects.

Individual differences in suppressive capabilities are discussed in relation to related research using various thought suppression paradigms. The relationship between thought suppression efficacy and neuroticism provides support of the executive deficit hypothesis, as neuroticism is highly correlated with executive control. Convergent evidence from paradigms measuring other personality traits that correlate with executive control and thought suppression on the TNT paradigm is discussed.

Dedication

The scope of this research would not have been possible without the gracious cooperation of a great many undergraduate students and persons otherwise who volunteered to be a part of my research, and I am forever grateful. Thank you, also, to the great many great people who have offered support since my early days at UBC and through my stay at the University of Auckland.

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Chapter 1: General Introduction

The experience of reality unique to every individual is created through the reconstruction of events through memory; our streams of consciousness are products of our perception of events and how they are recollected. Equally important for our existential reflections are the events and information that we cannot recall; information we have *forgotten*. In this sense it is useful to consider Augé's (2004) analogy of memory being a continent within a sea that is forgetting; forgetting is a necessary and integral force, shaping the outlines of the material that remains remembered and claiming the information that had too tenuous a grip to remain in memory. Research on intentional forgetting has shown that the ability to purposefully forget, to consciously remove information from consciousness, is well within the normal cognitive mechanisms of the human mind. This brings empirical strength to the discourse regarding potential mechanisms of repression; "expelling disturbing wishes, thoughts, or experiences from conscious awareness" (pp. 813; DSM-IV-TR; American Psychiatric Association, 2000). Repression is not prominently featured in the DSM-V (American Psychiatric Association, 2013), and issues once associated with repression are associated with less controversial terms such as dissociation. The aim of the research presented in this thesis is to explore forgetting of novel, ecologically valid stimuli; stimuli that would not be out of place in everyday, non-laboratory life. Furthermore, this thesis explores how individuals who differ in their self-knowledge of engaging in suppression as a coping mechanism perform on laboratory measures of suppression; are peoples' beliefs of their suppressive skills accurate? Suppression is commonly referred to as the conscious mechanism of forgetting, while repression is unconscious and more robust (Erdelyi, 2006). It is possible that rather than being two cognitive mechanisms divided by the spectrum of consciousness, that successful, conscious suppression may lead to unconscious repression. That is, suppression may be to repression what studying is to remembering; a mental device

to reach a memory-related goal. If suppression is one agent of many that may result in repression, illuminating the underlying mechanisms that allow suppression to occur is crucial in furthering our understanding of repression in its entirety. The existence of repression is, of course, highly contested, with a schism in support for the idea between clinicians and researchers (Patihis, Ho, Tingen, Lilienfeld, & Loftus, 2014); research oriented psychologists are typically much more sceptical of the existence of repression than clinicians and therapists, many of whom do not believe that repressed memories can be accurately retrieved (Patihis et al., 2014). However, to discuss memory suppression we need not immediately delve in to the realm of the repression debate. Memory suppression has been reliably, systematically observed in laboratory settings (Anderson & Levy, 2009). Memories that are suppressed initially (Noreen & MacLeod, 2013), may later be accurately retrieved after a long interval without continued suppression (Noreen & MacLeod 2014), and suppressive capabilities may differ depending on individual differences (Fawcett et al., 2015). Thus, remaining no less than an arm's length from the repression controversy, we begin by looking at the importance of forgetting, evidence for intentional forgetting, and the trajectory of the research presented in this thesis.

On remembering and forgetting

Approximately 28,000 years ago humanity realised the utility of using external devices to enhance one's ability to remember (external mnemonics; D'Errico, 2001). Using rudimentary tools, early humans were able to keep track of the passage of time by periodically marking wood and bones (Wynn & Coolidge, 2003). Paintings were etched on the walls of caves and scraps of wood, chronicling the successes of hunters and other noteworthy efforts (Mayer-Schönberger, 2009). After centuries of development, the symbolic representations created through painting were refined into the written word. As literacy gained popularity, and with the advent of the printing press, written texts could be rapidly

produced and disseminated, spreading their mnemonic contents well beyond their originator (Worthen & Hunt, 2011). The digital revolution saw to the global reach of the written word, making information more or less instantly accessible to anyone with internet access. The prevalence of external mnemonic devices is tremendous and their utility is profound in all modern societies, as we set alarms on our smart-phones, read the labels of soup cans, and read number plaques outside of lecture theatres to ensure we are attending the correct conference session. Fortunately, we are not solely reliant on external cues when the goal is increased memory functionality. Written in 55 BC, Cicero's *De Oratore* recounts the tale of Simonides of Ceos, a lyrical poet hired to deliver a poem at a ceremony in honour of the host's having won a chariot race (Worthen & Hunt, 2011). Simonides, after having performed, stepped outside to settle a dispute over his payment. While Simonides was outside, the roof of the building collapsed killing and disfiguring partygoers beyond identification. However, Simonides was able to accurately recall where each of the guests had been sitting and accurately identified the disfigured guests. This experience was the impetus for Simonides to create a mental mnemonic system, based on forming a mental image of a familiar place and then populating it with mental representations of to-be-remembered (R) information (Yarmey, 1984). So the *method of loci* was created; the first recorded mental mnemonic device. The development of mental mnemonics received scant, but crucial, attention in the centuries to follow: John of Garland discovered that rhyme schemes between familiar and unfamiliar concepts were beneficial to learning; Francis Bacon proposed a modified version of the method of loci for use in education; William James wrote of the importance of making systematic associations between R information and existent knowledge (Worthen & Hunt, 2011).

With the historical emphasis on *remembering*, it's difficult not to situate *forgetting* as the undesired outcome of memory failures, and perhaps justifiably so. After all, forgetting an

important point in a lecture, misplacing one's car keys, and failing to turn the stove off in the morning are not situations that are likely to elicit positive affect. A simple keyword search for "remember" in the PsychINFO database returns 7502 unique results, where a search for "forget" yields a relatively meagre 1880; only 379 of the total results from the two keywords contain both terms. This indicates that research on forgetting is not subsumed within research examining remembering, that they are indeed separate and that research on forgetting receives significantly less attention than the more desirable counterpart. However, as with many of life's great privileges, it may not be possible to know what you had until it's gone. As suggested by William James in 1890 (p. 68), "if we remembered everything, we should on most occasions be as ill off as if we remembered nothing." Clearly there is a balance to be struck between absolute memory capacity and absolute memory fallibility, which demands interplay between remembering and forgetting. In his treatise on the ability to forget and forgetting's role in shaping the information we remember, Augé (2004) proposes that one must forget the recent past to experience the present, and forget the recent past to remember the distant past. Without the ability to, at least temporarily, selectively retrieve (or prevent retrieval of) information from our memory stores we would effectively be stuck in an existential loop of remembrance. A woman by the moniker of AJ has a memory that does not stop (Parker, Cahill, & McGaugh, 2006). AJ is a *mnemonist*; a person with extraordinarily developed memory capabilities ("Mnemonist", 2002). Under empirical examination AJ produced near-ceiling, if not perfect, scores on a battery of memory indices. Although AJ reports that remembering is neither effortful nor difficult, her continuously accessed memory is detrimental to her being able to make decisions in the present and to move on from subjects of the recent past. From the age of 10, AJ obsessively catalogued events and details of her life in diaries. Doing so made her feel better, as though she no longer *needed* to remember the entries. A similar strategy was attempted by another mnemonist, known as S, who was

meticulously examined for nearly 30 years (Luria, 1987). While documenting information provided AJ peace of mind, S was not so fortunate. At first S would simply write things down but soon turned to more dramatic measures such as writing things down and then burning the paper he had written on. Despite fervent efforts, fixating on the destruction of external mnemonics proved fruitless. Also unlike AJ, S inadvertently discovered an effective technique of forgetting. S was a professional mnemonist, meaning that he routinely delivered performances that demonstrated extraordinary feats of memory. In attempting to remember a series of numbers he had memorized from the first of four performances he had given on April 23rd of an unnamed year, S found he was unable to bring forth the mental image of the board they were written on. This loss of memory, S speculated, was due to an active desire to *not* remember the numbers as he feared they would interfere with his remembering the numbers of his immediately upcoming performance. However, as Luria interjects, this supposition is merely conjecture; there is no way of knowing what role active inhibition played as much as there is no way of knowing what roles depth of encoding, attentional mechanisms, or other integral aspects of memory retrieval were involved. Though lacking in empirical merit, S's speculation provides grounds for the scientific exploration of intentional and motivated forgetting.

Intentional Forgetting

Intentional forgetting has been examined using paradigms of a variety of names, such as positive forgetting, voluntary forgetting, and, most commonly, directed forgetting (MacLeod, 1998). For simplicity, these studies will all be referred to as directed forgetting paradigms. Directed forgetting paradigms typically involve a retention interval between stimulus presentation and memory test brief enough to be considered to be testing *working memory*, though often may also be testing long term memory (LTM). The focus of this thesis is largely on the more enduring memory stores of LTM, however, which stores a potentially

limitless amount of information for a potentially indefinite period (Sternberg, 2009, pp. 188), and the forgetting thereof. Therefore, directed forgetting paradigms that focus on working memory forgetting will be covered only in relevance to related LTM forgetting literature (for in depth review of intentional forgetting see MacLeod, 1998; Golding, 2005).

Two common paradigm designs are used in working memory directed forgetting paradigms; the item procedure, and the list procedure. To generalize, the item procedure presents single stimuli followed (or, less commonly, preceded) by a cue to remember or forget the stimulus. The list procedure is much the same as the item procedure, but with multiple stimuli being presented between remember and forget cues. While the item procedure is generally straight-forward regarding remember and forget cues, the list method may involve deception. That is, participants may be led to believe that the to-be-forgotten list was presented by mistake and is therefore irrelevant (MacLeod, 1998). Designation of relevance may be crucial in the ability to forget information, and will be discussed further in the section regarding *motivated forgetting*.

An early study by Bjork, LaBerge, and Legrand (1968), utilizing the item procedure, found that instructions to forget the first of two consonant strings resulted in increased accuracy of the to-be-remembered consonant string, relative to trials where both were R. In trials where both strings were R, the second string tended to be recalled less accurately than the first string. Accuracy for the second string in trials including a to-be-forgotten (F) first string was most comparable to accuracy for strings in trials that included only one string, which was R. These results suggest that including instructions to forget the first of two stimuli reduces interference from the first stimulus on the ability to recall the second stimulus; it reduces *proactive interference*. However, letters from the F strings intruded on the recall test at a greater rate than did non-presented letters, precluding the possibility that the instructions to forget triggered complete erasure of the stimuli from memory.

Furthermore, intrusions from F strings strengthen Bjork and colleague's disposition that the stimuli were presented too rapidly for differences in encoding to produce such robust differences in remembering. Rather than active erasure, Bjork and colleagues theorized that F strings were actively "tagged" with the characteristic that they were not to be recalled, allowing for subjects to accurately separate the F from the R. Selective-rehearsal of R strings was also suggested to enhance recollection, but as the stimuli presentation was designed to minimize rehearsal this encoding-based explanation was not favoured. Bjork later repositioned his view from F items being tagged for segregation, to R items being tagged (p. 229, Bjork, 1972). If R items were being tagged for recollection, rather than F items for forgetting, it stands to reason that additional rehearsal time would work to the benefit of this additional encoding. If F items were being tagged for forgetting, this would theoretically be better facilitated by increased encoding time. This is somewhat paradoxical however, as increased encoding time would increase the probability that they would be encoded rather than forgotten.

Testing the effects of stimulus rehearsal time, Woodward and Bjork (1971) found no difference in memory performance between 1s or 4s stimulus presentation time. Presumably, subjects were waiting to see the cue at the end of the presentation time that precluded the potential advantage to encoding. Woodward, Bjork, and Jongeward (1973) contended that holding the stimuli in memory until the presentation of the cue was its own type of rehearsal, which should impact item memorability. In three separate experiments, subjects were shown four 36-word lists. The stimulus-cue delay varied (0, 1, 2, 4, 8, or 12s in Experiment 1; 0, 1, 4, 8, or 12s in Experiment 2; 0, 4, or 12s in Experiment 3), manipulating the amount of rehearsal time each word was allotted. Half of the words were followed by the cue to forget, and half by the cue to remember. In Experiments 1 and 2, subjects were given immediate recall tests for the R words after each of four lists and a delayed recall test for all presented

words after all lists had been presented. Relatively few F words intruded on the immediate recall tests in both experiments and much fewer were produced on the delayed recall tests, compared to the correctly produced R words. The amount of rehearsal time was not shown to affect the rate of recall on either test. In Experiment 3 the recall results replicated Experiments 1 and 2. However, an additional measure of item recognition presented after the final recall test showed significant effects of rehearsal time. While F words were recognized with lower accuracy than R words, accuracy increased for both F and R words as a function of rehearsal time. Due to the recognition test being administered after a considerable delay from the initial presentation of the word lists, Woodward and colleagues concluded that increased rehearsal time resulted in improved recognition for items in long-term memory. As we will see in depth below, increased rehearsal (or suppression) time is also critical in improving forgetting. Further, while forgetting of working memory information can be observed simply after including the direction to forget, the matter changes when the F information is already located in LTM. The following section discusses the necessary conditions for information to be wilfully removed from LTM.

Motivated Forgetting

In the cases of both AJ and S, two individuals who were highly motivated to forget, forgetting was attempted by the creation and destruction of external mnemonics. Unfortunately both mnemonists were unsuccessful in their endeavours to forget, something that mnemonologically normal individuals often wish to do away with altogether. However, instances do arise in the lives of individuals that may be desirable to forget. In this context, it is useful to think of information in memory as being consciously accessible and forgotten information as not consciously accessible. Information that is initially encoded and stored appropriately (i.e., consciously accessible) may become forgotten (i.e., not consciously accessible) for reasons attributable to intentional memory loss. This is the essence of

repression as a defense mechanism, proposed by Josef Breuer and Sigmund Freud (1895/1955). Breuer and S. Freud worked together to build the foundations of Psychoanalysis, which chiefly began with the treatment of their patient Anna O. (Markel, 2011). Personal differences drove the colleagues apart but S. Freud continued developing and publishing psychoanalytic techniques and papers for decades. Over his many publications, S. Freud used the term *repression* to describe the removing of information from conscious awareness both by conscious, voluntary mechanisms and by unconscious mechanisms (Erdelyi, 2006). Freud (1915/1957) formulated a concise definition of *repression*, proposing that “*the essence of repression lies simply in the function of rejecting and keeping something out of consciousness*” (p. 147, emphasis in original). However, a division was made between the conscious and unconscious processes of *repression* by Anna Freud (1936/1967): *repression* came to signify unconscious motivated forgetting and *suppression* came to signify conscious motivated forgetting.

The separation between conscious and unconscious processes of motivated forgetting was not congruent with S. Freud’s standpoint on consciousness, which was that consciousness was a continuum rather than a duality (1938/1964). That is, complex mental processes may be conscious *or* unconscious but the process is not altered based on what side of a hypothetical boundary between consciousness and unconsciousness it occurs on. Rather, S. Freud posited that the boundary between the conscious and unconscious is not a sharp divide but a gradient (1933/1964). The diagnostic definitions of *repression* and *suppression* given in the DSM-IV-TR (American Psychological Association, 2000) do little to address the delineation of *suppression* (“intentionally avoiding thinking about disturbing problems”) and *repression* (“expelling disturbing wishes, thoughts, or experiences from conscious awareness”[p. 813]). The disparity between the two definitions is that avoiding thinking about problems (*suppression*) is not tantamount to removing them from conscious awareness

(repression), but they are not mutually exclusive. That is, it is possible that thoughts may be removed from conscious awareness (i.e., forgotten) by consciously avoiding thinking about them.

An early study of suppression by Wegner and colleagues (1987) found that during periods of attempted thought suppression subjects reported thinking about a to-be-suppressed thought less than during periods where they were instructed to express the same thought. However, a paradoxical thought bias emerged when subjects first underwent suppression followed by expression compared to subjects who first underwent expression followed by suppression: subjects who suppressed the thought first expressed the thought more than did subjects who expressed it prior to suppressing it. This *post-suppression rebound* has been replicated in a number of paradigms that sought to address methodological concerns in the original method (e.g., Clark, Ball, & Pape, 1991; Clark, Winton, & Thynn, 1993; Wegner, Schneider, Knutson, & McMahon, 1991). Post-suppression rebound speaks to an aspect that Freud proposed to be necessary for repression to occur; that suppressive efforts must be continual for the undesired information to remain outside of conscious awareness, and that with effort the suppressed information may readily return to awareness (Erdelyi, 2006). Therefore a paradigm that induces multiple instances of suppressive attempts, rather than a single-shot of suppression towards a single piece of information, may be more apt to elicit suppression as seen in a clinical context.

The Think/No-Think Paradigm

Basic Design

Anderson and Green (2001) hypothesized that the suppression of undesirable thoughts may depend on the same executive control processes that Logan and Cowan (1984) theorized

to govern motor activation and inhibition. To test this hypothesis, they created a modified version of the widely used Go/No-Go (GNG) paradigm; the Think/No-think (TNT) paradigm. A typical GNG paradigm rapidly presents stimuli to which the subject is to respond with a button-press, except for when one particular stimulus is presented. The one critical exception stimulus is not to be responded to, and the subject's ability to withhold their response is thought to be a measure of executive control; one's ability to govern executive functioning. Executive function is somewhat of an umbrella term, encompassing a number of cognitive control mechanisms (Chan, Shum, Touloupoulou, & Chen, 2008), but most relevant for our concerns are the mechanisms of sustaining attention and cognitive flexibility. Exerting control over these mechanisms is critical in achieving accurate GNG responses; attention must be sustained on the task to detect changes in the rapidly presented stimuli, and cognitive flexibility allows for an alteration in response pattern to be made based on the detected change.

In the original publication, Anderson and Green's (2001) paradigm consisted of three phases; learning, TNT, and a final test phase. In the learning phase, participants were presented with 40 pairs of semantically unrelated or weakly-related words (e.g., ordeal-roach). Retention was tested by presenting the first word of each pair as a cue, to which participants were to respond with the non-presented paired-word (i.e., *target*). If participants were unable to accurately provide a target, they were presented with the cue-target pair visually. Participants would move on to the TNT phase after a minimum of 50% accuracy was achieved. Prior to the TNT phase, participants were first presented with 15 cues from the learning phase with the instruction that the targets associated with these 15 cues were to be mentally suppressed during the TNT phase; these constituted the *No-think* trials. For the remainder of the words, the *Think* trials, participants were instructed to verbally provide the targets to the visually presented cue words. The TNT phase then began, and cue words were

then presented in a random order 0, 1, 8, or 16 times. Stimuli at the 0 repetition mark serve as a baseline. Suppression can be implied to have occurred if No-think trials are worse recalled than items at baseline, and the converse is true for Think trials. If participants erroneously responded to a No-think trial, a loud beep signalled their error. Cue words were presented for up to 4s, or until participants responded. Participants were instructed to respond as quickly as possible. In the final test phase, participants were given two tests; a same-cue test and an independent-cue test. In both tests, participants were visually presented with a cue word and asked to provide the correct target word, regardless of whether they were Think or No-think trials in the TNT phase. The test cues were presented for 4s or until the participant verbally responded. In the same-probe test, the presented cues were the same cues as used in the previous phases of the paradigm. In the independent-probe test on the other hand, the cues were category names associated with the targets (e.g., *insect* for the target *roach*). Test order was randomized between participants. While the same-probe test determines if the targets association with the original cue is inhibited, it does not necessarily indicate whether the target was suppressed. The independent-probe test shows whether the target is suppressed relative to other members of the semantic category that were paired with baseline targets, which were not present in the TNT phase. Results from the three separate experiments reported show that participants were readily able to suppress target words in both same-probe and independent-probe contexts. A *negative control effect* (NCE) is present if fewer No-think targets are recalled than Baseline targets, indicating that suppression has occurred.

Variations in Design

After Anderson and Green's (2001) initial publication on the TNT paradigm, a number of labs adopted the paradigm to examine directed forgetting. The main issues taken with the original design of the TNT were that recall results for Think trials tended to hit

ceiling before the maximal trial repetition condition (i.e., 16 cue repetitions) and that the actual degree of forgetting seen for No-think trials was small, albeit significant. Below, we discuss the manipulations that have been tested in the TNT paradigm that have proven critical to the design and that have influenced the direction of our present research.

Amount of T and NT trials. The stimuli in Anderson and Green's paradigm were presented in the TNT phase 0, 1, 8, or 16 times. Differences in recall accuracy tended not to manifest until trial repetitions greater than 1, and the most disparity between Think and No-think trials tended to be for 16 repetitions. Some papers report using the same amount of repetitions as Anderson and Green (e.g., Hertel & Gerstle, 2003; Fischer, Diekelmann, & Born, 2011), but many have deviated from this scheme. Dieler, Plichta, Dresler, and Fallgatter (2010) used a limited repetition design, having participants only repeat Think and No-think trials 0 or 5 times. Participants were not found to be able to suppress targets after 5 trials. Four trials were also not found to be sufficient for suppression by Lambert, Good, and Kirk (Experiment 1, 2010), while their 16 trial condition was sufficient in eliciting suppression.

Emotional Valence. The TNT paradigm initially utilized word-pair stimuli with no specific regard to emotional valence; a factor that remains a controversial issue in memory research (see McNally, 2003, 2006). Before moving on to discussing emotional TNT paradigms, it is prudent to interject that instances that necessitate neutral information suppression do indeed exist in day to day life. Golding (pp. 184, 2005) takes note of several forms of single-item directed forgetting designs that would fit the criteria of important forgetting of neutral information; notably, forgetting incorrect directions to a destination (Golding & Keenan, 1985). Incorrect driving directions can hardly be categorized as emotionally negative

(although being lost *due* to incorrect directions may be), but are still likely to be subject to intentional forgetting once a correction has been obtained.

Hertel and Gerstle (2003) conducted a TNT study using adjective-noun pairs as the cue-target stimuli. By manipulating the adjectives for the pairs between subjects, they examined the effects of emotional valence on the suppressive effects associated with the paradigm. For example, the target noun “chair” would be emotionally positive if the cue adjective was “cozy” or emotionally negative if the cue adjective was “electric”. Participants were effectively able to suppress both positive and negatively valenced targets, and the valences did not significantly differ in susceptibility to suppression. A measured characteristic within the sample, depression, was also found to impact measures of suppression on the emotionally valenced TNT; this will be discussed further below. In two experiments, Lambert and colleagues (2010) found evidence divergent from Hertel and Gerstle (2003). In Experiment 1, stimuli pairs consisted of an emotionally valenced cue word and an emotionally neutral target word. This design allowed for the removal of the potential confound of emotion on the memorability of the targets by restraining it to the cues. Cue words were taken from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) and were either emotionally positive or emotionally negative. Emotional valence was used as the prompt to either rehearse or suppress, with half of the participants suppressing negatively associated targets and half suppressing positively associated targets. Cues were presented in the TNT phase 0, 4, or 16 times. Combined results of same-probe and independent-probe tests show that, after 16 repetitions, participants were able to significantly suppress negatively cued targets but not positively cued targets. Zero and 4 repetitions did not differ significantly, so Lambert and colleagues proceeded to use only a 0 repetition baseline and a 20 repetition condition (Experiment 2). Rather than having the emotional valence act as the prompt to rehearse or suppress, the colour that the cue was presented in during the TNT

phase demarcated trials as either Think or No-think. This adjustment allowed for the continued prevention of emotion impacting target memorability while allowing within-subject measurement of suppression between emotional valences. Again they found significant suppression occurring for targets cued by negatively valenced words and no such effect for targets with positively valenced cues.

A key criticism of the TNT paradigm, detracting from positing suppression as a laboratory parallel to repression, is that the degree of forgetting on No-think trials is modest at best (Kihlstrom, 2002; Hayne, Garry, & Loftus, 2006). The degree of forgetting seen in the emotional paradigms of Lambert and colleagues (2010) is perhaps a turning point in this trend. In Anderson and Green's (2001) original report, the same-probe test showed an approximately 7% NCE, and the independent-probe test showed an approximately 5% NCE. Lambert and colleagues (2010) found approximately 16% and 10% NCE in Experiments 1 and 2, respectively. Therefore, not only do we see that individuals are capable of suppressing emotionally valenced stimuli (Hertel & Gerstle, 2003), but we also see that emotional influence may actually increase suppressive capabilities. Butler and James (2010) conducted an examination of an emotionally valenced TNT paradigm, using an fMRI scanner to monitor participant's neural activity during the TNT phase. The results of their study failed to replicate any suppressive effects on the recall test, but they did find differential patterns of activation for Think compared to No-think trials. The neuroimaging results will be discussed below. Furthermore, the failure to replicate the suppressive effects of the TNT may come down to several important methodological differences specific to their paradigm, most notably being that TNT phase trials were only 2s in duration, compared to the usual 4s.

Stimuli. Moving on from the traditional word-pairs, more complex stimuli have been found to be susceptible to suppression as well. Hart (2006) reported three separate TNT paradigms

using emotionally neutral words paired with non-verbalizable shapes (Experiment 1), emotionally valenced words paired with emotionally neutral faces (Experiment 2), and emotionally neutral words paired with emotionally valenced faces (Experiment 3). Non-verbalizable shape targets were found to be susceptible to suppression, as memory performance decreased from rehearsed shapes to baseline shapes to suppressed shapes (Experiment 1). These findings encouraged further increasing the complexity of the stimuli, which in turn increased the ecological validity of the TNT paradigm. In Experiment 2 participants learned pairings of word-cues and face-targets, the cues being emotionally positive, negative, or neutral. After 1 repetition, Think and No-think trials did not differ from baseline. After 8 trials, on the other hand, faces were overall susceptible to suppression. Dividing the results by cue valence gives a somewhat different picture. For faces coupled with emotionally positive words, recognition decreased from rehearsed faces to suppressed faces to baseline faces. For faces coupled with emotionally neutral words, recognition was best for rehearsed faces, while suppressed and baseline faces did not differ. Lastly, for faces coupled with emotionally negative words, recognition decreased from rehearsed faces to baseline faces, to suppressed faces. These results suggest that emotionally positive stimuli are less susceptible to suppression, which is in line with Lambert and colleague's (2010) findings using a word-pair TNT paradigm. Hart took the paradigm one step further, emotionally speaking, and included an emotionally neutral condition as well. Finding that emotionally neutral and positive stimuli were not susceptible to suppression below the baseline level of remembering further potentiates TNT derived suppression as the beginning of a paradigm for examining repression. The trends of Experiment 2 were closely replicated in Experiment 3, with the only paradigmatic difference being that the cue words were emotionally neutral and the target faces demonstrated emotional neutrality, positivity, or negativity. These findings enrich those of Lambert and colleagues (2010) by showing that emotional valence impacts

susceptibility to suppression regardless of the item that is valenced, as well as by furthering the contention that emotionally positive stimuli are not particularly susceptible to suppression. To our knowledge, no research has been conducted where both the cue and the target are valenced.

Stimuli complexity was further increased in two experiments by Depue, Banich, and Curran (2006). In Experiment 1, the paradigm much resembled that of Hart (Experiment 2, 3, 2006) but with emotionally neutral faces acting as cues to either emotionally neutral or negative words. Again, emotionally negative stimuli were found to be more susceptible to suppression than neutral stimuli. In Experiment 2, neutral faces acted as cues to emotionally neutral and negative photographs taken from the International Affective Picture System (IAPS; Lang & Greenwald, 1988; Lang, Bradley, & Cuthbert, 2008). The IAPS offers a wide range of photographs, varying from 1 to 9 on scales measuring emotional valence and emotional arousal. For emotional valence, 1 demarcates the most negative valence and 9 demarcates the most positive valence, with emotional neutrality occupying a middle area that may vary slightly depending on the sample of photographs selected for the particular study. For emotional arousal, 1 indicates that the photograph does not elicit any physiological response whatsoever and 9 indicates that the photograph elicits as much physiological arousal as a photograph possibly could. Depue and colleagues (Experiment 2, 2006) again found that emotionally negative stimuli were more susceptible to suppression than were neutral stimuli. These findings lend well to the continued progression of stimuli complexity toward a more ecologically valid TNT paradigm, and the continued investigation of the impact of emotionality on suppressive susceptibility.

Rather than increasing the complexity of laboratory stimuli in the quest for increasingly natural stimuli, Noreen and MacLeod (2013) had their participants generate their own, autobiographical stimuli. In a novel approach, the researchers had participants generate

emotionally positive or negative autobiographical memories based on one cue word. One defining key-word for each memory was also provided by participants. In a subsequent session, participants learned cue-target pairs consisting of a novel neutral cue word and their memory key-words. While learning the cue-target associations, participants were provided with a verbatim transcription of the relevant memory. Across experiments, stimuli pairs were presented 16 times each throughout the TNT phase. Recall accuracy on a final cued recall test, in both experiments, showed a clear NCE for details of the events, but not for a gist-based recollection of the events themselves. Furthermore, in Experiment 1, it was determined that the NCE was largely due to the reduction in recall for negatively, but not positively, valenced memories. This was not replicated in Experiment 2, where recall accuracy for both emotional valences contributed significantly to the NCE. Regardless of the discrepancy between the impact of emotional valence between the two experiments, the presence of a robust negative control effect for emotionally valenced autobiographical memories lends support to testing further novel versions of the TNT utilizing participant-generated stimuli.

Individual Differences. In an analysis conducted on TNT data from their lab across a number of experiments, Levy and Anderson (2008) remark that some individuals are capable of achieving up to a 60% reduction in recall for No-think trials while some individuals experience the opposite effect, a rebound effect, of up to 40% (i.e., recalling 40% more No-think trial items than Think trial items). To accommodate for this disparity, the authors propose an *executive deficit hypothesis*. This hypothesis is based on neuroimaging work, discussed further in the following section, which has shown that intentional memory suppression is facilitated by activation of executive control regions (Anderson et al., 2004). Levy and Anderson propose that complex working memory span tasks, which have been extensively used to examine individual differences in executive control, should be able to

differentiate between individuals who are and are not able to elicit intentional suppression. This is precisely what Bell (2005) found; individuals with higher working memory scores were better able to suppression information than individuals with lower working memory scores (working memory measured via operation word span, La Point & Eagles, 1990) in Experiments 1 and 2. This relationship was only present for independent-probe memory scores, however, as same-probe scores did not vary reliably between high and low working memory participants.

Anderson and Kuhl (as cited in Levy & Anderson, 2008) found that individuals who reported having experienced more traumatic instances in their lives were better able to suppress No-think trials. Conversely, Klein and Boals (2001) found life stress to impair working memory capacity (Experiment 1, 2). Further, the recency of negative life stressors interfered with working memory performance that, in turn, was associated with higher self-reported intrusive thought experiences (Experiment 3). Neuroticism is intimately related to both executive functioning and intrusive thoughts (Munoz, Sliwinski, Smyth, Almeida, & Kling, 2013). Munoz and colleagues found neuroticism to be positively correlated with experiences of intrusive thoughts, and both neuroticism and intrusive thoughts to be negatively correlated to working memory performance. Thus, it seems that working memory and neuroticism are closely linked to individual differences in suppressive capabilities; increased working memory is associated with increased suppressive capabilities, and increased neuroticism is associated with decreased suppressive capabilities, which may be due to the negative correlation between working memory and neuroticism observed by Munoz and colleagues (2013).

Neuroticism is also highly correlated with *ruminat*ion; brooding and focusing on one's negative mood or experiences (Nolen-Hoeksema & Morrow, 1991; Muris, Roelofs, Rassin, Franken, & Mayer, 2005; Yoon, Maltby, & Joorman, 2013; Wenzlaff & Luxton,

2003). Fawcett and colleagues (2015) tested participants on a classic TNT paradigm and observed an overall NCE for suppressed targets (a 9% NCE). However, comparing low and high rumination participants revealed that the bulk of suppression was observed in participants who were low in rumination (a 16% NCE) whereas high rumination participants recalled only marginally less No-think than Baseline targets (a 3% NCE). Taken together, the research presented in this section clearly demonstrates the importance of considering personality and individual differences in studying thought suppression.

Neurophysiological Investigations of the TNT Paradigm

Differentiating between the results of suppression and rehearsal within a strictly behavioural paradigm gives us insight into whether individuals are able to suppress information, but there is no difference in the behavioural outcomes of successful suppression and unsuccessful rehearsal; the target is not produced. Taking neuroimaging measurements during thought suppression activities therefore provide valuable insight into the differences in cognitive processes involved in passive and active forgetting. Event related potential (ERP) research will be discussed, followed by functional MRI research (fMRI), and lastly a magnetoencephalography (MEG) study. Although the novel TNT paradigms we employ in this thesis do not include neurophysiological measures, it is useful to consider evidence from the following studies.

Subjective familiarity for information in episodic memory is accompanied by a larger late positive component (LPC) over parietal electrode sites, compared to perception of unfamiliar stimuli, at 400-800ms after stimulus onset (Friedman & Johnson, 2000). The amplitude of the component increases with increased exposure to the recollected stimuli (Johnson, Kreiter, Russo, & Zhu, 1998). Using an electroencephalograph (EEG) to monitor participant ERPs during the TNT phase, Bergstrom, Velmans, de Fockert, & Richardson-

Klavehn (2007) found a significant reduction in left parietal LPC during No-think trials, compared to Think trials; an effect that has since been replicated a number of times (Bergstrom, de Fockert, & Richardson-Klavehn, 2009; Hanslmayr, Leibold, Pastotter, & Bauml, 2010; Mecklinger, Parra, & Waldhauser, 2009). Thus the suppressive mechanisms engaged by the TNT are effective at reducing the neural signature of familiarity; however none of the above imaging studies produced a significant NCE. Furthermore, using MEG equipment, Tesarek (2008) found No-think trials to be accompanied by an early (96-140ms) increase in left frontal activity for all subjects. This activation was not indicative of successful suppression however, as it did not correspond to later recall accuracy and was present in subjects who were generally unable to suppress information in the paradigm as well. These findings, along with those of Bergstrom and colleagues (2007; 2009), Hanslmayr and colleagues (2010), and Mecklinger and colleagues (2009) suggest a certain level of neural activation present in suppressive efforts that is not indicative of suppressive success. Specifically, unsuccessful suppressive attempts are characterized by decreased a parietal LPC and increased left frontal activity. Conversely, Tesarek (2008) found successful suppression to be accompanied by a late (770-870ms) decrease in right parietal activity. This pattern was only evident on No-think trials for subjects who successfully suppressed the trials target, as evinced by failure to recall on the subsequent recall test. The decreased parietal LPC linked to unsuccessful suppression is present between 400-800ms after stimulus onset, whereas the increase associated with successful suppression slightly overlaps this timeframe and extends beyond it. Furthermore, the unsuccessful suppression decrease is left lateralized, whereas the successful suppression increase is right lateralized. These finding demonstrate a neurological difference between successful and unsuccessful suppressive mechanisms, but also demonstrate that they are similar in nature, with a slight overlap in temporal space and in opposing hemispheres of the same brain region.

The utility of ERP studies is limited to observing cortical structures, which leaves out subcortical structures that are generally synonymous with memory research; the hippocampal and amygdalar areas. Filling this deficit, Anderson and colleagues (2004) used fMRI scanning to monitor participants' neural activity during the TNT phase of a standard word-pair TNT paradigm. During No-think trials, a network of brain regions were more activated than during Think trials including the bilateral dorsolateral and ventrolateral prefrontal cortices (DLPFC and VLPFC, respective), the anterior cingulate cortex (ACC), and several motor areas. For the most part, this network represents structures that are integral in executive control functions. Further analysis showed that increased bilateral DLPFC activation predicted successful suppression, as indicated by scores on the final recall test. This gives neurophysiological support to the assertion that suppression is facilitated through executive control, mentioned above. Furthermore, hippocampal areas showed differential activation between rehearsed and suppressed items as well. Overall, the hippocampus was bilaterally less active during No-think trials than Think trials. However, an interaction between trial type and post-test accuracy showed differential activation for Think and No-think trials. Think trial items that were successfully recalled showed greater hippocampal activation than Think trial items that were not successfully recalled. Conversely, No-think trial items that were *not* successfully recalled showed greater hippocampal activation than No-think trial items that were recalled. The interaction between trial type (Think vs. No-think) and post-test accuracy on hippocampal activation indicates that intentional forgetting elicits a different pattern of activation than unintentional forgetting.

In a similar paradigm, Butler and James (2010) used an fMRI scanner to collect neuroimaging data during the TNT phase of their paradigm. Unlike Anderson and colleagues (2004), Butler and James manipulated the emotional valence of target stimuli, using emotionally neutral and negative target words. As mentioned previously, behavioural results

did not show susceptibility to suppression for No-think trials. However, the neuroimaging data showed similar patterns of activation to Anderson and colleagues. Comparing No-think trials for neutral and negative stimuli, the data showed that hippocampal regions were only less active for No-think trials than Think trials for emotionally neutral stimuli. Emotionally negative No-think trials did however elicit greater activation of the left amygdala than did emotionally neutral No-think trials and both valences of Think trials. These results give further support to the importance of evaluating emotional valence in the TNT paradigm.

Trajectory of Thesis Research

The goal of the research reported here is to explore the impact of repeated suppressive attempts on memory recall for stimuli that have not been utilized in previous TNT literature. Paradigms utilizing stimuli that are relatively more complex than simple word pairs (Hart, 2006; Depue et al., 2006; Johnson, Craske, Aikins, 2008; Tesarek, 2008; Noreen & MacLeod, 2013) begin to bridge the gap between laboratory and real-world stimuli. The evidence shows that the intentional forgetting effect of the TNT continues to be observed when the complexity of stimuli is increased. This thesis further builds on the novel approaches to utilizing the TNT paradigm for three separate end goals. Firstly, a large scale survey was conducted to compare personality traits between individuals who vary in personal beliefs of their own use of thought suppression in daily life, and the success thereof. The results from this survey guided the comparisons between groups varying in individual difference traits in the data from the subsequent laboratory experiments. Secondly, the effects of repeated thought suppression on contextual information of photographic stimuli are examined. Contextual information comprises a great deal of the content of episodic memories, and influences the perception of the core elements of the memory. If contextual information is forgotten, the interpretation of the central elements of a memory may change altogether.

Thirdly, the work of Noreen and MacLeod (2013; 2014) was extended by utilizing stimuli that were as yet unexplored in the TNT paradigm - imagined episodic events. The three prongs of research covered in this thesis are introduced below. Each area receives a more detailed exposition in the relevant chapter.

Suppressive Self-knowledge and Individual Differences

For the purpose of explicitly gauging individuals' beliefs regarding their tendencies to utilize suppression as a coping mechanism for dealing with undesirable information, and the efficacy of their memory suppression strategies, the Retrospective-Pro prospective Suppression Inventory (RPSI; see Appendix A) was created. This inventory provides a direct measure of individuals' overt self-knowledge of their experiences of suppression, both in terms of frequency and efficacy. A sample of survey respondents completed a digital survey package, including the RPSI and several indices that have been previously linked to suppression; the Eysenck Personality Questionnaire (EPQ-R; Eysenck, Eysenck, & Barrett, 1985), the Social Desirability Scale (SDS; Crowne & Marlowe, 1960), the White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994), the Ruminative Response Scale (Treynor et al., 2003). This sample provided the first direct look at the differences between individuals who believe that they do or do not engage in suppression, and those who do or do not believe that their suppressive efforts are effective. The results from this study, along with previous literature examining individual differences in suppressive abilities, allowed for predictions to be made regarding individual differences in performance on the subsequent TNT paradigms conducted for this thesis.

Contextual Information

While the intentional forgetting of target stimuli in the TNT paradigm is a valuable observation, there has not yet been any exploration on whether suppression is detrimental to recall of information related to suppressed materials that is not directly suppressed or rehearsed. Episodic memories are coloured not only by the central elements within, but also by the context in which those elements are experienced. Noreen and MacLeod (2013) found that while target memories were recalled with similar gist-based accuracy across TNT instruction conditions, details for suppressed memories were recalled less than details for rehearsed or Baseline memories. However, the details reported were intrinsically relevant to the target stimuli, as they were components of the memories themselves. Even remembering the general gist of each memory would increase the likelihood of recalling details of each memory. Thus, how can we test memory for information pertaining to suppressed stimuli without inherently re-cueing the contextual information? To approach this issue, we utilized a novel TNT paradigm design. In 2 experiments the impact of TNT instructions on recall of items within a series of photo-matrices was examined. Within each matrix some images were paired with cues (i.e., target images), and these cues were then used to instruct the rehearsal or suppression of the relevant images. Many images within the matrices remained unpaired (i.e., context images), and existed solely to act as contextual cues to target images. These contextual images were not directly paired with TNT instructions to rehearse or suppress. Instead, analyses compare fluctuations in contextual image recall depending on which TNT instruction was associated with items *adjacent* to themselves. That is, if the TNT instructions attached to target items affect adjacent items which themselves have no TNT instruction, then it is the case that rehearsal or suppression of information affects the memorability of related information. Furthermore, in this design it is possible for contextual images to be influenced by the TNT instructions attached to multiple adjacent target items. Having context images shared between multiple target images allows for the additional consideration of the potential

strength of Think and No-think instructions. That is, if Think and No-think instructions affect recall of context images, we can determine if having the context image associated with multiple Think or No-think target images increases or decreases likelihood of recall. Further, we can observe the impact of context image recall when it is associated with competing TNT instructions. Experiment 1 utilizes the procedure described here with separate photo-matrices of 9 items, while Experiment 2 utilizes a simplified procedure with separate photo-matrices of 3 items each. The different approaches are discussed at length in Chapter 3 of this thesis.

Imagined Events

Rather than looking at the forgetting of stimuli that participants have personally experienced, and thus might prove resilient to forgetting insofar as the participants have already readily accessed them to provide descriptions for cue-target pair fabrication, participants in two experiments fabricated their own stimuli. That is, rather than using autobiographical memories for stimuli, participants generated plausible imagined events for the purposes of the experiment; self-generated, self-relevant stimuli without a supporting network of contextual information and episodic cues otherwise. This procedure allowed participants to report and repeatedly rehearse self-relevant events with a highly negative valence without the ethical concerns of having participants recollect particularly traumatic past experiences or mentations. As Addis, Pan, Vu, Laiser, and Schacter (2009) demonstrated, remembering past episodic events and imagining future episodic events rely largely on shared cognitive and neural mechanisms. This *default network* (Andrews-Hanna, 2012; Schacter, Addis, & Buckner, 2007; Addis et al., 2009) includes the hippocampus, posterior cingulate/retrosplenial cortex, inferior parietal lobule, and lateral temporal cortices. Further examination by Addis et al. (2009) unveiled two distinct subsystems within the core network; an imagining subsystem, and a remembering subsystem. Thus, determining if events

that rely on the imagining subsystem are susceptible to suppressive attempts will provide valuable insight on the reach of suppressive mechanisms.

This line of research comprises 2 experiments and an overall comparative analysis, each with a relatively large sample. Given that the degree of suppression observed in the TNT literature fluctuates between individuals as much as it does (Levy & Anderson, 2008), it is especially critical to employ a large sample in an investigation utilizing novel stimuli. A large sample allows for the detection of a smaller-than-usual NCE, or a NCE that is present in fewer participants than would be observed using word-pairs or other previously investigated stimuli. Experiment 3 explored the impact of TNT instructions on memory for imagined future events, both in respect of recall accuracy and phenomenological ratings (i.e., emotionality, imagined detail, and similarity to past experiences or thoughts). Recall accuracy was assessed for elements that were presented to participants to spur the generation of the imagined future events. Experiment 4 furthered this line of research by manipulating the temporal direction of imagined events. Participants were randomly assigned to either imagine future events, or to imagine plausible but fictitious past events. Further, participants were not only tasked with recalling the target items as in Experiment 3, but also with re-telling each imagined event. Descriptions of the imagined events are compared between pre-TNT and post-TNT instances and assessed for accuracy as a second measure of the influence of TNT instructions.

Chapter 2: Individual Differences in Suppressive Self-knowledge

The ability to actively avoid thinking about unpleasant or otherwise undesirable information is a skill that varies between individuals; whether the information is a traumatic experience or an annoying altercation in traffic, it is often important to a task at hand to suppress unwanted information. Thought suppression can also result in maladaptive behaviour; suppressing thoughts regarding symptoms of illness may have negative consequences such as leading to more serious courses of treatment than would have been required with earlier detection. Precise knowledge of the breadth of individual differences integral to successful thought control and, ultimately, suppression remains elusive. In the work described in this chapter, the relationship between metacognitions about the consequences of thought suppression and personality traits that have been associated in previous work (Munoz, Sliwinski, Smyth, Almeida, & King, 2013; Levy & Anderson, 2008) with thought suppression was examined. The executive deficit hypothesis (Levy & Anderson, 2008) predicts that successful suppression is contingent on executive control. This hypothesis is supported by evidence from neuroimaging (Anderson et al., 2004; Anderson & Hanslmayr, 2014), which revealed a network of executive control regions that support memory suppression. In particular, individual differences in the recruitment of the lateral prefrontal cortex during suppression predicted the amount of memory inhibition. Decreases in cognitive abilities associated with normal aging, in particular the ability to ignore distracting thoughts, are also associated with reduced memory inhibition (Anderson, Reinholz, Kuhl, & Mayr, 2011) and increased susceptibility to the effects of intrusive thoughts (Hasher, Zacks, & May, 1999).

Neuroticism is intimately related to both executive functioning and intrusive thoughts (Munoz et al., 2013). Munoz and colleagues found neuroticism to be positively correlated with experiences of intrusive thoughts, and both neuroticism and intrusive thoughts to be

negatively correlated to working memory performance. Neuroticism was measured with a brief inventory, comprising 10 statements of the emotional stability factor of the International Personality Item Pool (IPIP; Goldberg et al., 2006) that participants rated for how well each item described themselves. Emotional stability IPIP item scores correlate highly with EPQ-R neuroticism sub-factor scores (Gow, Whiteman, Pattie, & Deary, 2005), which is the measure of neuroticism used in the present study. Similar to the present study, Munoz and colleagues measured intrusive thoughts with the WBSI (Wegner & Zanakos, 1994). The WBSI measures participant agreement with a series of statements concerning the experience of intrusive thoughts in a variety of circumstances.

Convergent evidence comes from Luciano, Algarabel, Tomás, and Martínez (2005), who developed a psychometric inventory to measure individual differences in the ability to cope with ruminations, thought intrusions, and otherwise negative thoughts; the Thought Control Ability Questionnaire (TCAQ; e.g., “It is very easy for me to stop having certain thoughts”). Where a high score on the WBSI would be indicative of the preoccupation with intrusive thoughts, increasing scores on the TCAQ are indicative of greater levels of mastery over the content of one’s stream of consciousness. This distinction is relevant as where Munoz and colleagues (2013) found neuroticism to be positively correlated to the prevalence of intrusive thoughts, Luciano and colleagues (2005) found neuroticism to be negatively correlated with one’s mastery over unwanted mentations. The combined result is that increased neuroticism is related to increased experiences of intrusive thoughts and overall reduced mastery of the content that reaches the forefront of one’s mind.

Further convergent evidence of the link between working memory and intrusive thoughts comes from a study of life stress and working memory capacity (Klein & Boals, 2001). Life stress was found to impair working memory capacity (Experiment 1, 2) as measured on Turner and Engle’s (1989) operation-word span working memory test. The

recency of negative life stressors interfered with working memory performance that, in turn, was associated with higher self-reported intrusive thought experiences (Experiment 3). Similarly, Brewin and Smart (2005) found working memory capacity to be negatively correlated to experiences of thought intrusions during a suppression paradigm that had participants either suppress or express their personally identified most-common intrusive thoughts. However, working memory capacity was not found to be associated with the reported frequency of intrusive thoughts in everyday life.

Suls and Martin (2005) describe a *neurotic cascade*; individuals high in neuroticism are motivated to engage in thought suppression, even though their attempts at suppression may prove unsuccessful, as described above. Emotionally negative information may be better suppressed than emotionally positive information (e.g., Lambert, Good, & Kirk, 2010; Noreen & Macleod, 2012). According to the *Neurotic Cascade*, highly neurotic individuals appraise events as more harmful or threatening, and negative affect from stressful experiences may carry over to adjacent experiences or thoughts that may not be negative *per se*. This predilection to experience emotionally negative events leads highly neurotic individuals to allocate more attention to events perceived as negative, and to remember those events in more detail (see Rusting, 1998). This overly negative outlook tends to be comorbid with *ruminat*ion; brooding and focusing on one's negative mood or experiences (Nolen-Hoeksema & Morrow, 1991; Muris, Roelofs, Rassin, Franken, & Mayer, 2005; Yoon, Maltby, & Joorman, 2013; Wenzlaff & Luxton, 2003). Attending and ruminating on emotionally negative events along with a reduced capacity for suppression certainly leaves highly neurotic individuals at a disadvantage in terms of the potential for intrusive, unwanted thoughts.

As this review has illustrated, research carried out to-date has examined a range of individual differences associated with suppression and thought intrusion. However, a critical

question has yet to be addressed: Do individuals who engage habitually in thought suppression, and experience this cognitive strategy as successful, differ from those who engage in the same strategy but experience their attempts at suppressing unwanted thoughts as unsuccessful? The purpose of the studies presented in this chapter is to determine if personality traits associated with suppression reliably vary between groups that report different levels of suppressive success. A survey method was used to address this question because our comparison of personality attributes between groups who reported success and failure, with regard to thought suppression, required a relatively large sample size. A longer term aim of this work is to use insights from this exploratory study of individual differences to test specific hypotheses regarding inter-relationships between personality attributes, self-reports of thought suppression, and laboratory performance of tests of executive functioning and memory suppression (Levy & Anderson, 2008).

Thus, while previous work has shown that high neuroticism is associated with increased frequency of intrusive thoughts (Munoz et al., 2013), in the current study we addressed a novel set of inter-related questions: Do individuals who vary in the tendency to engage habitually in thought suppression, *and* with regard to the self-reported success or failure of thought suppression, differ with respect to trait neuroticism, the tendency to engage in rumination, and the frequency of intrusive thoughts? We employed a novel measure to differentiate participants who believe they have not engaged in suppression (i.e., non-suppressors) from those who report having engaged in suppression either successfully (i.e., successful suppressors) or unsuccessfully (i.e., unsuccessful suppressors). Our measure, termed the Retrospective and Prospective Suppression Inventory (RPSI) makes the above three differentiations in both a retrospective and prospective sense; whether the individual has engaged in suppression previously, and will they engage in suppression in future instances of undesirable thoughts.

Personality Traits of Individuals Who Differ in Suppressive Capability Beliefs

It was hypothesized that trait neuroticism will be, as previously observed, positively correlated to the experience of intrusive thoughts (Munoz et al., 2013) and rumination (Muris et al., 2005; Yoon et al., 2013). We predict that individuals who report utilizing suppression will have higher levels of trait neuroticism, intrusive thought prevalence, and rumination than individuals who do not report utilizing suppression. Further, we predict that trait neuroticism, intrusive thought prevalence, and rumination will vary between non-suppressors, successful suppressors, and unsuccessful suppressors. Specifically, unsuccessful suppressors are predicted to possess traits associated with decreased executive function. Lastly, robust differences between genders have been previously observed for neuroticism (Costa, Terracciano, & McCrae, 2001), intrusive thoughts (Wegner & Zanakos, 1994), and rumination (Nolen-Hoeksema & Jackson, 2001); females tend to score higher than males on all three measures. Supplementary analyses will determine if differences observed between RPSI groups are subject to gender differences.

Method

Participants. Two hundred sixty eight adults (207 female, 54 male, 7 undisclosed; mean age = 22.79) were recruited through an advertisement posted on the University of Auckland School of Psychology website, which contained a secure link to the digital survey.

Measures. The survey package was accessed digitally, and the surveys were presented in a fixed order. After completing a digital consent form, participants could access the body of the survey.

To assess participant suppressive tendencies, we devised the Retrospective-Prospective Suppression Inventory (RPSI). The RPSI consists of five questions, regarding firstly past suppressive tendencies (“In the past, when you have had experiences you wish to forget, did you consciously try to forget the experience?”) and the efficacy of the suppression (“Were your efforts to forget the memory successful?”), secondly expected future suppressive tendencies (“In the future, if you experience something highly unpleasant, would you consciously try to forget the experience?”) and supposed efficacy of the suppression (“Do you think you would be able to successfully forget about the unpleasant experience?”), and lastly the general attitude towards the acceptability of suppression in dealing with undesirable information (“In your opinion, is trying to forget an unpleasant or undesirable experience a reasonable way to come to terms with an unchangeable event?”).

The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) is a 15-item scale designed to measure the general experience of intrusive thoughts. Each item is rated on a 5-point scale from strongly disagree to strongly agree, and pertains to incidence of intrusive thoughts and suppression (e.g., “I wish I could stop thinking of certain things”; further details and scoring in Wegner & Zanakos, 1994).

Participants completed the Eysenck Personality Questionnaire (EPQ-R; Eysenck, Eysenck, & Barrett, 1985). The 48-item inventory provides personality data across four dimensions; neuroticism, extraversion, psychoticism, and social desirability (i.e., the lie subscale). Each item on the scale is a question to which participants respond in the affirmative or the negative, depending on if the item applies to them (e.g., “Are you an irritable person?”). Twelve items of the EPQ-R belong to the neuroticism subscale (i.e., EPQ-N). Though the neuroticism subscale is the only EPQ-R subscale of interest in the present study, participants completed the entire scale to prevent response bias.

The Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991) provides an index of how frequently individuals engage in mentation dwelling on negative thoughts. Items inquire to the prevalence of specific thoughts or behaviours (e.g., “[How often do you] think about all your shortcomings, failures, faults, mistakes?”) and are rated on a 4-point scale, ranging from “almost never” to “almost always”.

Results

All questions on the RPSI included the option to not provide a response. As such, the group sizes in the following analyses vary accordingly.

Bivariate correlations were calculated between experiences of intrusive thoughts and rumination, and neuroticism scores. Neuroticism was highly associated with intrusive thoughts ($r = .535, p < .001$) and rumination ($r = .622, p < .001$). Intrusive thoughts were also highly correlated with rumination ($r = .640, p < .001$). These results confirm that the presently measured sample conforms to previously established trends (Munoz et al., 2013; Muris et al., 2005; Yoon et al., 2013; Wenzlaff & Luxton, 2003).

Suppressive Tendencies. Of the participants who chose to respond to the retrospective RPSI (i.e., RPSIr) questions ($N = 259$), 172 participants indicated that they had engaged in suppression in the past, and 87 participants indicated they had not. Separate t-tests showed that past suppressors had significantly higher scores on the neuroticism scale [$t(257) = 3.007, p = .003$], WBSI [$t(257) = 6.363, p < .001$], and RRS [$t(257) = 3.112, p = .002$] than did non-suppressors. See Table 2.1 for mean neuroticism, WBSI, and RRS scores. This pattern was replicated for participant groupings based on the prospective RPSI (i.e., RPSIp) question of whether participants would engage in suppression in the future. Of those who chose to respond ($N = 255$), 148 participants indicated that they would engage in suppression

in the future, and 107 participants indicated they would not. Separate t-tests showed that future suppressors had significantly higher scores on the neuroticism scale [$t(253) = 4.429, p < .001$], WBSI [$t(253) = 6.807, p < .001$], and RRS [$t(253) = 3.212, p = .001$] than did non-suppressors. These results show that individuals who report suppressive tendencies, regardless of whether it is retrospective or prospective, experience more intrusive thoughts and rumination, and have higher neuroticism.

Table 2.1

Mean Inventory Scores (SD) by RPSIr suppressive tendency and score ranges

Scale	RPSIr affirmative	Range	RPSIr negative	Range
EPQ-N	7.49(3.35)	0-12	6.17(3.27)	0-12
WBSI	56.29(10.70)	20-75	47.33(10.54)	27-72
RRS	29.46(13.49)	5-64	24.30(10.60)	4-58

Suppressive Efficacy. The key analysis of interest is in determining whether unsuccessful suppressors differ from both successful suppressors and non-suppressors in neuroticism, intrusive thoughts, and rumination. Univariate ANOVAs were used to compare unsuccessful suppressors ($N = 95$), successful suppressors ($N = 66$), and non-suppressors ($N = 87$) on neuroticism, intrusive thoughts, and rumination.

Neuroticism decreased from unsuccessful suppressors, to successful suppressors and non-suppressors [$F(2, 245) = 9.201, p < .001, \eta^2 = .070$], see Table 2.2 for mean neuroticism scores. Pairwise comparisons showed that unsuccessful suppressors had significantly higher neuroticism scale scores than successful suppressors ($p = .010$) and non-suppressors ($p < .001$). Mean neuroticism scale scores did not differ between successful suppressors and non-suppressors ($p = n.s.$). Successful suppressors demonstrated a similar level of neuroticism to

non-suppressors, while unsuccessful suppressors score on the high-end of the neuroticism spectrum.

WBSI scores differed significantly between suppressor groups [$F(2, 245) = 24.057, p < .001, \eta^2 = .164$], with scores increasing from non-suppressors, to successful suppressors, to unsuccessful suppressors, see Table 2.2 for mean WBSI scores. Pairwise comparisons showed that unsuccessful suppressors had significantly higher WBSI scores than successful suppressors ($p = .025$) and non-suppressors ($p < .001$), and that successful suppressors had significantly higher WBSI scores than non-suppressors ($p = .001$). Although successful suppressors report more intrusive thought experience than non-suppressors, unsuccessful suppressors score in the highest end of the spectrum.

Rumination decreased from unsuccessful suppressors, to successful suppressors and non-suppressors [$F(2, 245) = 7.655, p = .001, \eta^2 = .059$], see Table 2.2 for mean rumination scores. Pairwise comparisons showed that unsuccessful suppressors had significantly higher RRS scores than successful suppressors ($p = .039$) and non-suppressors ($p = .001$). Successful suppressors and non-suppressors did not differ significantly ($p = .951$). Successful suppressors demonstrated a similar level of rumination to non-suppressors, while unsuccessful suppressors score on the high-end of the rumination spectrum.

Table 2.2

Mean Inventory Scores(SD) by Suppressor Group and score ranges

Scale	Non-suppressor	Range	Successful suppressor	Range	Unsuccessful suppressor	Range
EPQ-N	6.17(3.27)	0-12	6.61(3.36)	1-12	8.17(3.24)	0-12
WBSI	47.33(10.54)	27-72	53.65(11.06)	21-74	58.12(10.04)	20-75
RRS	24.30(10.60)	4-58	26.33(13.12)	6-61	31.32(13.43)	5-61

Gender Differences. To determine if gender differences were a significant influence in the findings presented in the above analyses, a multivariate ANOVA was conducted to examine differences in our personality measures between males and females who indicated that they had or had not engaged in suppression in the past. The interaction between gender and RPSI response was not significant ($p = .791$). Neuroticism scores were significantly higher for females ($M = 7.014$, $SE = .250$) than males ($M = 5.934$, $SE = .467$), with $F(1, 248) = 4.166$, $p = .046$, $\eta^2 = .017$. WBSI scores were significantly higher for females ($M = 52.486$, $SE = .801$) than males ($M = 48.263$, $SE = 1.496$), with $F(1, 248) = 6.139$, $p = .014$, $\eta^2 = .024$. RRS scores did not vary significantly between genders ($p = .2$), but were higher on average for females ($M = 27.137$, $SE = .945$) than males ($M = 24.752$, $SE = 1.765$). These findings indicate that while males and females in our sample differ in neuroticism and the experience of intrusive thoughts, these group differences do not significantly affect our observed differences in the above analyses.

Discussion

The results presented here replicate previously observed correlations between intrusive thoughts, rumination, and neuroticism (Munoz et al., 2013; Muris et al., 2005; Yoon et al., 2013; Wenzlaff & Luxton, 2003). As predicted, individuals who endorsed having engaged in suppression scored higher on measures of neuroticism, intrusive thoughts, and rumination than individuals who did not endorse having engaged in suppression. Furthermore, unsuccessful suppressors demonstrated higher neuroticism, intrusive thoughts, and ruminations than successful suppressors and non-suppressors. Successful suppressors were only differentiated from non-suppressors on the measure of intrusive thoughts;

successful suppressors are characterized by low levels of neuroticism and rumination, and a medium occurrence of intrusive thoughts.

Munoz and colleagues (2013) found high-neuroticism individuals to have reduced working-memory capacities, which may correspond with reduced suppressive abilities (Levy & Anderson, 2008). Our findings here build on this observation to suggest that high-neuroticism individuals in the unsuccessful suppressors group are also aware of their suppressive shortcomings. Our results also support the Neurotic Cascade (Suls & Martin, 2005); individuals who possess traits that predispose them to experience events as emotionally negative do report engaging in suppressive attempts. However, individuals who *do not* possess these traits *also* report engaging in suppression: successfully. Successful suppressors may be well suited for suppression: low levels of neuroticism indicate an unencumbered working memory and a lack of executive deficit; a low prevalence of ruminative thoughts suggest that the individuals are able to avoid repeatedly rehashing negative life experiences; the presence, but not abundance, of intrusive thoughts suggests that the individuals experience instances they would like to suppress and, coupled with a lack of executive deficit, are able to do so when desired.

As previously established in the literature, females scored higher than males on neuroticism, intrusive thoughts, and, to a lesser extent, rumination (Costa et al., 2001; Wegner & Zanakos, 1994; Nolen-Hoeksema & Jackson, 2001). These differences did not significantly contribute to the differences observed between RPSI groups, but do give cause to mention two limitations to be addressed in future endeavours. Firstly, our sample was largely female. As females tend to score higher on all three of our inventories of interest, this may impact overall means in a significant way. Secondly, while rumination scores were higher for females than males in our sample, the difference was not significant. This is likely a by-product of our un-even sample, as evidenced by the relatively large standard error SE

that the male group demonstrates for all three measures in section 3.4. These issues can be remedied for further examination by taking care to include equivalent numbers of each gender in future samples.

A crucial future initiative, in considering the small difference observed in the present study between successful suppressors and non-suppressors, would be to further examine individual differences in suppressive tendencies. It may well be the case, as observed in the dichotomous split based on efficacy within the categories of past and future suppressors, that the designation of non-suppressor is too-broad a classification. Non-suppressors in the present sample have traits that would likely allow them to successfully engage in suppression, yet they report that they do not. It is a logical possibility that some individuals who are designated as non-suppressors may be better classified as *unaware*-suppressors: minimal levels of neuroticism, rumination, and intrusive thoughts would suggest that if information was suppressed it would have little opportunity to resurface. An experimental extension of the present study would allow for the detection of unaware-suppressors, should they indeed be a present, as of yet undetected group in our sample. For example, having individuals complete the battery of measures from the present study in accompaniment of a TNT paradigm would allow for a comparison between empirical measurement of suppressive capability and meta-cognitive awareness of the ability to effectively suppress. Where the present study used neuroticism as a marker of executive deficit without a direct test of executive performance, an ideal future endeavour would include an empirical measure of executive performance (e.g., Levy & Anderson, 2008; Munoz et al., 2013).

Support from behavioural literature. The present study endeavoured to expand the knowledge-base regarding individual differences in suppressive capabilities. We have achieved this by providing a novel glimpse at the differences between not just individuals

who do or do not engage in suppression, but also between those who believe they *can* or *cannot*. Two recent landmark studies have begun what is likely to be a pervasive trend in all future TNT research; Küpper, Benoit, Dalgleish, and Anderson (2014), and Dieler, Herrmann, and Fallgatter (2014) found greater levels of suppression on TNT paradigms in individuals who possessed traits that have above been implicated in higher suppressive capabilities.

Küpper and colleagues (2014) utilized an object-scene TNT paradigm, where simple images of everyday items (e.g., a clothes hanger) acted as cues and emotionally negative IAPS images acted as targets. Using this paradigm, Küpper and colleagues (2014) found that suppression reduced overall recall of the targets, as well as recall for details within the scenes. Despite using only highly negative IAPS photographs as targets, the degree of forgetting observed was on par with research utilizing emotionally neutral stimuli with a 6% NCE. Taken at face value this, albeit significant, small NCE is curious in comparison to the relatively large NCE often observed for emotionally valenced stimuli in the TNT paradigm (e.g., Lambert et al., 2010; Noreen & MacLeod, 2013). However, Küpper and colleagues (2014) further analyzed their data by creating a between-subjects variable consisting of two groups; high-TCAQ and low-TCAQ individuals. In remembering that TCAQ scores are negatively correlated with neuroticism, it is perhaps unsurprising that Küpper and colleagues found high-TCAQ individuals to demonstrate a 10.5% NCE and low-TCAQ individuals to demonstrate a meagre 2.1% NCE for overall target recall. High-TCAQ individuals also suppressed more specific details of the targets than did low-TCAQ individuals.

In a similar study, Dieler and colleagues (2014) employed a face-scene TNT paradigm, where emotionally neutral faces served as cues and IAPS images that were either emotionally neutral or emotionally negative served as targets. Unlike Küpper and colleagues (2014), Dieler and colleagues (2014) found no overt NCE for emotionally negative or

emotionally neutral targets. However, regression analyses of suppression of emotionally neutral and emotionally negative targets including several candidate individual difference measures revealed two particular indices that predicted suppression; anxiety and brooding. Scores of trait anxiety, which is particularly closely linked with neuroticism (Muris et al., 2005), and brooding, which is derived from a subscale of the RRS, were used to create two separate between-subjects variables; high and low anxiety, and high and low brooding. As anxiety and brooding (as well as rumination) are known correlates (Nolen-Hoeksema & Morrow, 1991; Muris et al., 2005; Yoon et al., 2013; Wenzlaff & Luxton, 2003), they were submitted to analysis as covariates. Low scorers of the two co-varying traits were found to demonstrate a significant NCE for emotionally negative targets, while high-scorers demonstrated considerable rebound effects for suppressed targets. This pattern of results was absent for emotionally neutral targets; the regression analysis did not reveal any measure traits to predict target suppression.

Proceeding with experimental research based on the current findings. The findings of both Küpper and colleagues (2014) and Dieler and colleagues (2014) lend support to the assertions made in the present chapter that individuals who vary in neuroticism will likewise vary in suppressive capabilities. While the TCAQ provides a latent measure of self-knowledge of suppressive capabilities, it does not allow for the between-subjects designations that the RPSI has demonstrated above. Therefore, in considering in conjunction the results from the present study and from both Küpper and colleagues (2014) and Dieler and colleagues (2014), the trajectory of the remainder of this thesis will be not only to design and test novel TNT paradigms that approximate realistic conditions, but also to further uncover the nature of individual differences in suppressive self-knowledge, latent personality traits, and actual suppressive skills. Moreover, as perhaps best demonstrated by Dieler and

colleagues (2014), a strong NCE can be washed out from traditional analyses entirely without consideration of crucial individual differences. Therefore, all further experiments presented in this thesis will consider both traditional (i.e., mainly within-subject) and revised (i.e., incorporation of between-subject measures as well as the tradition within-subject comparisons) methods of analysis. This approach will allow the potential discovery of suppression where it may otherwise have been hidden, and the discussion of whether it is always relevant to consider the individual differences discussed above in relation to the TNT paradigm. Specifically, as Dieler and colleagues (2014) report, emotionally neutral suppression was not predicted by the measured traits. If this trend persists, it would support existent literature examining emotionally neutral target suppression in TNT paradigms without consideration of individual differences; perhaps emotionally negative and emotionally neutral suppression are both possible, but rely on differing characteristics.

Chapter 3: Contextual Memory in Think/No-Think Paradigms

Episodic memory contains the descriptive and contextual information we use to engage the world and construct our existence (Tulving, 1985). Not included in previous formats of the TNT paradigm is measurement of the forgetting of not just the central item of an episodic memory (i.e., the target), but for the surrounding contextual details that characterize each memory. The context of a central item in an episodic memory may not be intrinsically related to the central item, such as knowing what time it is (context) when reading a passage in a book (central item). Or the context may be crucially related to the central item, such as the glass of wine on the railing (context) while viewing a particularly stunning sunset (central item). The research presented in this chapter explores the question of what happens to contextual information when a central item is subjected to suppression.

This previously unexplored area of thought suppression was explored by creating, and modifying, a new version of the TNT paradigm. In order to measure memory for contextual information, the structure of the TNT paradigm needs to be fundamentally altered. Rather than having stimuli pairs, single cue stimuli were paired with items within item matrices. The closest venture in TNT literature to the paradigms proposed here are those that utilize photographs as target stimuli (Depue et al., 2006, 2007; Tesarek, 2008). While IAPS photographs are certainly more complex stimuli than ANEW items (e.g., affective word stimuli used by Lambert et al., 2010), they tend to be a singular, semantically cohesive scene. For example, IAPS item 5622 (Lang & Greenwald, 1988) features a SCUBA diver holding on to a shark underwater, with some coral in the foreground. This stimulus is more visually comprehensive than the appearance of a single word stimulus (e.g., “tomato”), but the semantic connections of the scene render it as one stimulus rather than an array of stimuli. This complicates the findings of Depue and colleagues (2006, 2007), insofar as it is possible that certain elements of the IAPS photographs were successfully suppressed, but the entirety

of the scene was not. Returning to IAPS item 5622, for example, it is possible that a participant might suppress the shark element of the photograph while recalling the SCUBA diver. Moreover, it is possible that if some of the critical scene elements were indeed suppressed (i.e., shark, diver), contextual elements remained associated to the cue (i.e., coral). The opposite is also possible, with the critical elements being recalled and the contextual information being lost. Lastly, it is possible that both the critical and contextual elements be suppressed, resulting in a total loss of ability to recall the stimulus in response to the previously associated cue. The latter possibility is the most robust form of forgetting possible in the TNT paradigm, and would likely result in a failure to recall the target in response to an independent probe cue (e.g., swimming, ocean).

In the common endeavour of this thesis, participants in the following experiments will also provide us individual differences data. Of specific interest, as previously, are scores of neuroticism and responses to the RPSI. As we have seen in previous literature (Fawcett et al., 2015; Levy & Anderson, 2008; Bell, 2005), individual differences are crucial factors to consider in analyses of TNT results. The stimuli used in the experiments of this chapter were purposefully chosen to convey emotional neutrality. Comparing individuals differing in neuroticism on these paradigms will provide the first evidence of whether neuroticism is crucial in the suppression of emotionally neutral information.

Experiment 1

The present paradigm will begin to address the novel question of whether contextual information is retained for stimuli that undergo suppression attempts but are subsequently recalled. Rather than using IAPS photographs as targets, we sought to use elements within visual scenes that remained distinct and unrelated to the other items within the same scene while not seeming bizarre in relation to other items in the scene. This novel approach to the

TNT paradigm uses item matrices: arrays of 9 items arranged in a 3 x 3 matrix. Each item within a matrix is treated as a stimulus, rather than the whole of the matrix being considered a singular stimulus. In this way, each singular item within a matrix can potentially be paired with a TNT instruction and the impact of multiple, perhaps even disparate, TNT instructions on contextual stimuli can be observed. As in previous TNT paradigms, the present paradigm still features cue-target pairings. The unique feature at present is that the target item is featured within a matrix, making target location an important feature for participants to remember. If a matrix includes, for example, one Think target and one No-think target, then some of the contextual items for the targets would be unique to each target, while some would be shared between targets (see Figure 3.1 for an example matrix that depicts this scenario). Contextual items are operationally defined as items that are directly adjacent to target items.



Figure 3.1. Example item matrix containing one *Think* target (top left corner; sock) and one *No-think* target (bottom right corner; ribbon).

Similarly to previous TNT paradigms, memory performance is predicted to decrease from targets paired with cues associated with Think instructions, to Baseline instructions, to No-think instructions. Contextual items that were uniquely associated with a single target item (i.e., unique items) are predicted to follow a similar pattern of recall as the targets they are associated with. Items that are shared between more than one target, however, are predicted to be recalled differentially depending on the TNT instruction associated with the targets. These shared items (e.g., the wrench in Figure 3.1) were assessed as accurately recalled if they are recalled as a contextual item for either or both associated targets (i.e., the recall test for the target “sock” or the target “ribbon”). Overall recall for contextual details for accurately recalled targets were predicted to decrease from Think, to Baseline, to No-think target contextual associates. Shared item accuracy was predicted to vary by the instruction type of both the target for which context is being recalled, and the instruction type of other overlapping targets. This weakening of connections to contextual information is predicted to occur as a by-product of the suppressive efforts made on the targets that share these contextual items. That is, suppressive efforts on targets degrade the memory trace for related, contextual information.

Following the example of Fawcett and colleagues (2015), the data collected in this experiment will be treated with traditional analyses that do not consider individual differences, and revised analyses that do. Comparing memory data in the present experiment between groups divided by neuroticism scores will allow for a direct examination of suppressive differences for emotionally neutral information and the context thereof. Recall performance is predicted to differ between neuroticism groups. This prediction is grounded in the assumption that suppression of emotionally neutral information is dependent on the same cognitive processes as suppression of emotionally valenced information.

Method

Participants. Fifty-one University of Auckland students volunteered to participate in this study. Participants were compensated for their time with a 10\$ voucher.

Materials. Sixty-three images were selected at random from the Bank of Standardized Stimuli (BOSS; Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010). Twenty-four emotionally neutral words were selected from the ANEW (Bradley & Lang, 1999), with a mean valence of 5.17 and a mean arousal of 3.92. Of the 63 BOSS images, 18 were randomly selected to be paired with ANEW words. These 18 word-item dyads were split into three groups for counterbalancing purposes; the designation of Think, No-think, or Baseline was cycled through these three groupings between participants. The remaining 6 ANEW words were used as filler words in the procedure, and the remaining 45 BOSS stimuli were used as context images.

The BOSS images were compiled into seven 3 x 3 matrices. A singular number matrix was also created, where each of the nine matrix locations was occupied by the numbers one through nine. Images that had been paired with words were strategically distributed and arranged so each of the following permutations was featured in two matrices: Think and No-think targets adjacent; Think and Baseline targets adjacent; No-think and Baseline targets adjacent; Think targets not adjacent to other targets; No-think targets not adjacent to other targets; Baseline targets not adjacent to other targets. These matrices can be seen in Appendix B, along with cues depicting the aforementioned permutations. This complex arrangement was necessary to prevent participants from needing to memorize too many matrices before engaging in cue-target pairing, as that may have ultimately reduced final recall abilities.

Procedure. Prior to engaging in the experimental procedure, participants completed a survey package that included an informed consent form, the N and L subscales of the EPQ-R, and the RPSI. Once the survey was completed, the participant completed the experiment in five phases. See Figure 3.2 for a graphical representation of the procedure.

Learning phase. Participants were shown each of the seven item matrices serially. Participants saw an item matrix for 20s, followed by the number matrix for 20s. Each item in the matrices occupied 21% of the total height and 21% of the total width of the monitor, and the matrix was presented in the middle of the right half of the monitor. Participants were instructed to verbally reconstruct the previously viewed item matrix while viewing the number matrix. This was achieved, at the participants' preference, either by linearly listing each item from the first through ninth position in the presented number matrix or non-linearly by stating the number position and item that belonged in that position. If participants were unable to report the contents of the matrix with 100% accuracy, they viewed the matrix again followed by the number matrix. Participants took an average of 2.7 item-number cycles per matrix to achieve 100% accuracy. The learning phase ensures that participants have attended to all matrix items, not only items that are paired with words in the subsequent *pairing phase*. Once 100% accuracy was achieved in the learning phase, by correctly recalling 100% of the items in each of the 7 serially presented matrices, participants entered the pairing phase.

Pairing phase. Participants were exposed to 18 trials that featured one unique word on the left side of the screen in a size 18 font and one of the seven item matrices on the right side of the screen. Within the current item matrix, one item was surrounded by a yellow border; thus creating a word-item (cue-target) pairing. These trials lasted for 5s and were separated by a 1s ISI featuring a central fixation.

Cued recall test. Each of the 18 cue words, and an additional 6 unrelated filler words, were then shown in size 18 font on the left side of the screen for 7s each accompanied by the number matrix on the right side of the screen for visual reference. Filler words were included to prevent forced-choice guessing by allowing that some of the words presented were not paired with an item. The words were presented serially, in a randomized order. Participants were instructed to verbally recall the name of the target item that had accompanied each word, or say “absent” if the word had not been previously paired with an item. Accuracy was assessed only on the basis of the correct target being recalled for target-present cues, or filler cues being correctly rejected, and not on the provision of the target’s location within the matrix. If participants scored at or above the criterion accuracy of 50%, they moved on to the *TNT phase*. If not, they would repeat the pairing phase.

TNT phase. Participants were serially presented with 12 of the 18 cues that had been paired with targets. Each cue was presented 16 times, evenly over the course of four blocks of 48 trials, for a total of 192 trials. Each trial lasted 5s, featuring a single centrally presented cue word in a size 18 font, followed by a 500ms ISI featuring a central fixation cross in a size 18 font. Of the 12, six were designated as Think cues, and six were No-think cues. This was accomplished by presenting the cues in green and red, respectively. Participants were not instructed to use specific strategies on engaging in either Think or No-think trials, but were instructed to look directly at the cue stimuli for the entire presentation period. The designation of a cue as Think or No-think (or Baseline by exclusion) was counterbalanced between participants.

Testing phase. Each of the 18 cues and 6 filler words were presented serially, in a randomized order, for 10s or until a response was made. Participants were instructed to verbally recall the name of the target item that had accompanied each cue, or say “absent” if the word was not believed to have been previously paired with an item. If participants correctly recalled the target for a cue-target pairing, the target would appear in the number matrix where it had originally been situated. Participants were instructed that this time was to be used to list as many items as possible that had been immediately adjacent to the now-visible target. The target remained on screen for 10s while participants listed as many of the adjacent items as possible.

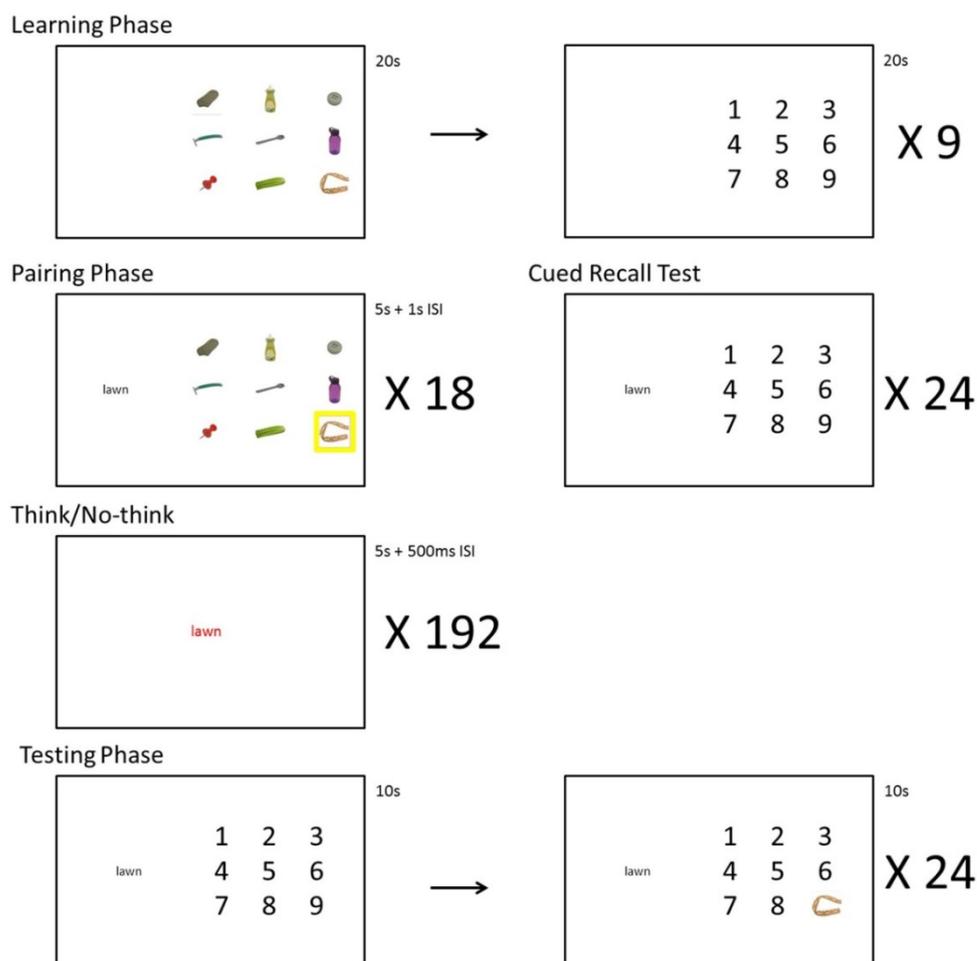


Figure 3.2 The visual elements, timing, and repetition of the procedure of Experiment 1.

Results

Of the 51 participants, 46 achieved the criterion level of accuracy. Incorrect responses from 3 participants were lost during coding, leaving 43 participants to be eligible for analysis. Individual differences were not considered in these analyses.

Target Accuracy. A mixed design 2 (learning phase attempts per participant) x 2 (test occasion) x 3 (TNT instruction) ANOVA was conducted, comparing raw participant accuracy scores from pre-TNT and post-TNT testing instances. Learning phase accuracy scores from the final learning phase cycle the participant completed were used in this analysis. See Table 3.1 for accuracy means. Learning phase attempt number showed no main effect [$F(1, 41) = .000, p = .984, \eta^2 = .000$] or higher order interactions, so the analysis collapsed across learning phase attempts and was reconducted as a 2 x 3 repeated measures ANOVA. TNT instructions did not affect accuracy significantly [$F(2, 84) = 1.543, p = .220, \eta^2 = .035$]. Accuracy differed significantly between test occasions [$F(1, 42) = 10.081, p < .001, \eta^2 = .338$], with accuracy decreasing from pre-TNT ($M = 4.566, SE = .132$) to post-TNT ($M = 4.171, SE = .144$). This decrease in accuracy between test occasions did not differ significantly by TNT instruction [$F(2, 84) = 2.649, p = .077, \eta^2 = .059$]. For descriptive statistics, see Table 3.1. Without the interaction between test occasion and TNT instruction, we are unable to conclude that the reduction in accuracy between testing occasions is due to the presence of a NCE. We are also unable to conclude that Think target accuracy was affected by rehearsal. Thus, we are left to conclude that accuracy declined as a function of the brief retention interval between testing occasions, irrespective of the content of the interval. It may be the case that target stimuli were highly memorable, or that the paradigm lent well to

maintaining access to memories for target stimuli, insofar as recall accuracy at post-TNT is 91.35% that of accuracy at pre-TNT.

Table 3.1

Mean target accuracy(SE) by TNT instruction category and test occasion

	Think	No-Think	Baseline	Total
Pre-TNT	4.67 (.187)	4.53 (.174)	4.49 (.192)	4.56 (.132)
Post-TNT	4.49 (.222)	4.16 (.188)	3.86 (.232)	4.17 (.144)
Percent Recalled	96.1%	91.8%	85.9%	91.4%

Contextual Accuracy. To be considered a contextual item, the item was required to be directly adjacent to the relevant target. Contextual items for Think and No-think targets were either unique to the target, shared with an opposing Think target, shared with an opposing No-think target, or shared with a Baseline target item. Contextual items for Baseline targets are classed as either unique to the target, shared with a Think or No-think target. Differentiating between whether a Baseline contextual item was shared with a Think target or a No-think target was not possible in the present paradigm, due to repeated overlap between Think and No-think target proximity to Baseline target contextual associates. This left the dataset with an impoverished glimpse at Baseline contextual recall, and necessitated separate analyses of contextual item recall accuracy for Think, No-think, and Baseline targets.

The opportunity to recall contextual items was contingent on the participant first correctly recalling the target. Each target item had a maximum number of possible contextual item associates, and each contextual associate was either unique to the target or shared with

another target. The maximum number of contextual associates differed slightly between items, and therefore between TNT instruction categories. Therefore instead of comparing raw contextual associate recall scores, a proportion-correct value was calculated for each TNT target category for each participant. This way participant contextual recall proportions are accurately compared without bias due to the slight imbalance in possible contextual associates. If a target item was not recalled, then the number of possible contextual associates that were associated with the target were removed from the proportion-correct calculation. Only participants who were able to provide at least one accurate contextual response are included in the analyses for accurate responses.

Accurate Contextual Responses. For descriptive statistics pertaining to the following analyses, see Table 3.2.

A repeated measures ANOVA for total contextual response accuracy between TNT instruction types found no significant difference in total accurate contextual items recalled between Think ($M = .080$, $SD = .093$), No-think ($M = .062$, $SD = .085$), and Baseline ($M = .066$, $SD = .086$) targets [$F = .664$, $p = .517$, $\eta^2 = .016$]. Thus, TNT instruction did not affect the rate of overall accurate contextual item recall.

A repeated measures ANOVA comparing contextual response accuracy for unique contextual items between TNT instruction targets showed no significant difference between TNT instruction target unique contextual item accuracy [$F(2, 66) = 1.377$, $p = .259$, $\eta^2 = .037$].

Due to the characteristics of accurate contextual recall fundamentally differing between levels of the TNT instruction variable (Think target contextual items can be shared with No-think contextual items, but not with Think target contextual items, and vice versa for No-think target contextual items; Baseline target contextual items may have been shared with

Think or No-think target contextual items), the contextual levels of each TNT instruction were examined separately.

A repeated measures analysis for Think target accurate contextual responses (unique, shared with No-think, shared with Baseline) showed that contextual recall differed significantly between proximity conditions [$F(2, 72) = 6.705, p = .002, \eta^2 = .157$]. Performance decreased from unique, to shared Baseline, to shared No-think contextual recall scores. Pairwise comparisons show that shared No-think accuracy was significantly lower than unique accuracy ($p = .001$) and shared Baseline accuracy ($p = .04$). Unique and shared Baseline accuracy did not differ significantly ($p = .3$). These results show that Think target contextual accuracy recall is significantly hindered if the contextual items were also adjacent to a No-think target. This effect is not likely due to contextual items being more difficult to recall simply due to being shared by more than one target, as accuracy did not differ between unique context accuracy and shared Baseline context accuracy. Rather, when Think target contextual items are adjacent to a secondary No-think target then they are recalled less often than when they are shared with a secondary Baseline target or with no secondary target at all.

A repeated measures analysis for No-think target accurate contextual responses (unique, shared with Think, shared with Baseline) showed that recall accuracy did not differ between proximity conditions [$F(2, 74) = 1.361, p = .263, \eta^2 = .035$]. Performance decreased from shared Baseline, to unique, to shared Think contextual recall scores.

A repeated measures analysis for Baseline target accurate contextual responses (unique, shared with Think or No-think) showed that accuracy did not differ between proximity conditions [$F(1, 35) = .438, p = .512, \eta^2 = .012$], with performance decreasing from unique to shared contextual recall scores. These results show that recall accuracy for No-think and Baseline contextual items is not affected by the proximity of competing TNT targets. This is unlike the effect seen on Think target contextual recall, where attempting to

suppress adjacent information hinders recall. The absence of an inverse effect, a relative increase of recall for No-think target contextual items that are shared with Think targets compared to recall for uniquely No-think target contextual items, suggests that suppression and rehearsal influence contextual recall differently.

Table 3.2

Mean contextual target (SE) recall accuracy by target TNT instruction and adjacent target TNT instruction

Target	Unique	Think	No-think	Baseline
Think	.137 (.032)	*	.031 (.009)	.106 (.024)
No-think	.051 (.021)	.051 (.013)	*	.085 (.023)
Baseline	.101 (.038)	.076 (.014)		*

Results Considering Individual Differences

At all stages of the RPSI, participants are offered the opportunity to not respond. The number of participants in the following analyses varies accordingly, but does not include participants who were excluded from previous analyses.

Personality Inventory Relationships. To determine if the present sample demonstrated previously established relationships between RPSI responses and neuroticism, a one-way ANOVA was conducted on neuroticism scores between RPSI response groups. Unsuccessful suppressor (N = 12) neuroticism scores (M = 7.83, SE = .901) were significantly higher than Non-suppressor (N = 20) scores (M = 4.90, SE = .698; $p = .043$) and marginally higher than Successful suppressor (N = 6) scores (M = 4.50, SE = 1.274; $p =$

.119), with $F(2, 35) = 3.896, p = .03, \eta^2 = .182$. Successful suppressors and Non-suppressors do not differ significantly ($p = 1$). The present results indicate that our sample is semi-typical, insofar as Unsuccessful suppressors are more neurotic than Non-suppressors, but deviates from previous findings insofar as Successful suppressors mediate the two groups and differ significantly from neither. This finding deviates from the results presented in Chapter 2 insofar as Successful suppressors did not differ significantly in neuroticism from Non-suppressors, and both Successful suppressors and Non-suppressors were significantly less neurotic than Unsuccessful suppressors. This deviation may in part be due to the relatively small size of the Successful suppressor group in the current sample.

Neuroticism Score Distribution. Two neuroticism groups, created by median split, will be compared; low (Mean = 3.70, SD = 1.34; N = 22) and high (Mean = 8.89, SD = 1.96; N = 18) neuroticism.

Target Accuracy by Neuroticism groups. A mixed design 2 (low vs. high neuroticism) x 2 (test occasion) x 3 (TNT instruction) ANOVA was conducted on raw target accuracy scores. No main effect or higher order interactions were observed for TNT instruction (all $p > .1$). Neuroticism groups did not differ on recall accuracy scores ($p = .7$). However, the interaction between neuroticism and testing occasion trended towards significance [$F(1, 38) = 3.278, p = .078, \eta^2 = .079$]. The difference between low neuroticism participant pre-TNT (M = 4.52, SE = .174) and post-TNT (M = 4.273, SE = .191) recall was smaller than the difference between high neuroticism participant pre-TNT (M = 4.759, SE = .193) and post-TNT (M = 4.185, SE = .211) recall. Overall, recall accuracy decreased significantly from pre-TNT (M = 4.645, SE = .130) to post-TNT (M = 4.229, SE = .142) testing occasions [$F(1, 38) = 22.631, p < .001, \eta^2 = .373$].

Contextual Accuracy. Parallel to above analyses of contextual response accuracy irrespective of individual differences, analyses were conducted for accurate contextual responses comparing low and high neuroticism participants. See Appendix C for these analyses.

Discussion

Our prediction of observing a NCE for target items was not confirmed, and this was not mediated by participant neuroticism. Although the overall amount of target forgetting observed between pre and post-TNT testing occasions was larger for low-neuroticism participants than for high-neuroticism participants, target recall for both groups was irrespective of TNT instruction. These results do not support the previously identified differences between participants varying in traits associated with suppressive capabilities observed by Fawcett and colleagues (2015); low neuroticism participants did not demonstrate a NCE. Present findings also do not replicate previous findings of the forgetting of emotionally neutral stimuli regardless of individual differences (e.g., Anderson & Green, 2001). The method used in this novel paradigm deviated from traditional TNT paradigms by necessity, as we were interested in measuring the impact of TNT instructions on contextual information.

Traditional planned comparisons, irrespective of neuroticism, show that when participants are attempting to recall contextual items for Think targets they are significantly less likely to recall items that had been shared with No-think targets than items that had either been shared with Baseline targets or items that were unique to the Think target. However, when attempting to recall contextual items for No-think targets, recall did not differ significantly between shared (with Think *or* Baseline targets) or unique items. Contextual

recall per TNT instruction permutation did not exceed 12% and 18.6% of the maximum amount of context items possible as shown in Table 3.2 and Table 3.3, respectively. These recall values are considerably lower than the recall of targets (that had been correctly recalled at pre-TNT testing), as shown in Table 3.1, at an average of 91.4% across all TNT categories. Despite the relatively low level of overall contextual item recall, the difference between Think target contextual items shared with Baseline targets and those shared with No-think targets (6.7%) is approximately on par with the average NCE seen in previous TNT literature (Anderson & Levy, 2006). That is, if this effect can be replicated through methodology that is not impeded by a floor effect for contextual item recall then this experiment has provided the first evidence of a NCE occurring for the context of suppressed targets in a TNT paradigm.

However, analyses that compare recall accuracy for contextual items between low and high neuroticism participants provide a more nuanced pattern of results than those above. The observed decrease in Think target contextual item recall when the contextual item was also associated with a No-think target compared to a Baseline target or no additional target was observed in low-neuroticism participants, but not high-neuroticism participants. The difference, for low-neuroticism participants (see Table 3.3), between contextual item recall for items shared with No-think and Baseline targets is higher than previously thought (9.3%). This contextual-NCE suggests that low-neuroticism participants experience more forgetting of the context of information they attempt to remember (i.e., Think targets) if the context is also involved with something they attempt to forget (i.e., No-think targets). High-neuroticism participants, on the other hand, recalled more contextual items for No-think targets if the contextual item was also associated with a Baseline target than if it were also associated with a Think target or not additional target. This pattern was not present for low-neuroticism participants, and was not detected in analyses that did not consider neuroticism as a measure of interest. This previously undetected pattern suggests that high-neuroticism participants

paradoxically recall more context of suppressed information (i.e., No-think targets) if the context was additionally associated with information that was neither suppressed or rehearsed (i.e., Baseline targets). Paradoxically, if the context is additionally associated with rehearsed information (i.e., Think targets) it is recalled less. This is further true for context that is unique to the suppressed information. It seems that high-neuroticism participants anchor contextual information shared between actively suppressed and otherwise benign (i.e., Baseline) information to said benign information, which aids later recall. Although target recall did not vary between analyses that did or did not consider neuroticism as a variable, in this first direct look at the vicarious impact of competing rehearsal and suppression on stimuli that were themselves never directly rehearsed or suppressed it is critical to consider individuals differences between participants. However, extrapolating the information from this paradigm is problematic due to several deviations that were necessitated by the exploratory nature of this first contextual paradigm.

A notable deviation in the present design from previous TNT paradigm renditions is that our design featured a total of 18 targets; 6 targets per TNT instruction. This is a reduction from previous paradigms, which typically feature a larger number of cue-target pairings to be divided amongst TNT instruction conditions (e.g., 24 cue-target pairs, Lambert et al., 2010; 40 cue-target pairs, Depue et al., 2006; 40 cue-target pairs for TNT instruction conditions and 10 filler cue-target pairs, Anderson & Green, 2001). This reduction was enacted for two reasons. Firstly, we sought to adequately counterbalance the potential impacts of TNT instructions on shared contextual items without overburdening participants by using more item matrices than necessary. That is, we created the minimal amount of matrices possible to evenly observe the impact of Think on No-think context, Think on Baseline context, and No-think on Baseline context. However, since the data collection process did not facilitate the differentiation between No-think and Think contextual items that were shared with Baseline

targets, this will need to be addressed in future renditions of this paradigm. This leads to the second reason for the reduction in cue-target pairings; to ensure that participants were indeed able to accurately recall contextual items. However, participants were not able to perform at a particularly high level on the contextual recall element of this paradigm. The grand average for contextual recall, across TNT instructions, was 7%. This is relatively low, considering that participants were able to recall 91.3% of targets that they had accurately identified on the pre-test. Two factors that potentially contribute to this relatively low contextual recall level are that participants were not attending to the contextual items as mnemonic aids during the cue-target pairing phase, and that there was a relatively high ratio of contextual items to target items. It is perhaps the case that while participants actively attended target items during cue-target pairing, they actively avoided attending the numerous surrounding items as to avoid distraction. Further, it is clear that having participants engage the matrices in their entirety before the pairing phase was not an effective measure to ensure retention of non-target matrix items. This relative floor effect of contextual recall potentially contributed to the absence of differences between overall contextual accuracy and false alarms between TNT instructions on the present paradigm. A final concern in the present paradigm is the serial presentation of item matrices in the learning phase, where participants are first exposed to the matrices. It is conceivable that participants would have a more difficult time recalling items from the matrices presented earlier in the initial learning phase, than those that were presented later. This will be addressed in the following experiment by using simpler item arrays, combining the initial learning phase and pairing phase, and by presenting the item arrays in a randomized order, multiple times for item arrays that feature multiple cue-target pairings.

The next direction for our research of TNT paradigms with distinct contextual information for targets involves refining the design of the present study. Methodological

issues outlined above will be addressed in a less complex and more succinct paradigm. In moving towards a simpler design we are able to increase the number of targets while decreasing the overall number of contextual items, simultaneously addressing limitations described above.

Experiment 2

In this experiment, rather than introducing participants to item matrices and using matrix members as target stimuli, the target stimuli were situated in triads of items. It was most often the case, in Experiment 1, that if a participant was able to recall contextual information for a target it would be a single item. Reducing the item matrices from 9 to 3 items creates cue-target pairings with a maximum of 2 contextual items, therefore reducing the complexity of attempting to recall the contextual items. This will not limit participants' recall dramatically as participants are not likely to recall more than one contextual item per target. Furthermore, this paradigm will allow differentiation between Baseline target contextual stimuli that are proximal to either Think *or* No-think targets. This modification addresses a critical limitation from Experiment 1; Baseline contextual accuracy will now be directly comparable to Think and No-think contextual accuracy. Reducing the number of potential context items for each target will also allow for the increase of the number of targets, as the demand on participant memory will be reduced. This is predicted to benefit the data in two ways. Firstly, reducing the number of contextual items present in the paradigm is predicted to increase the relative proportion that participants are able to recall. Secondly, increasing the number of targets in the paradigm is predicted to reduce overall participant target recall accuracy that will ameliorate the relatively low level of change in recall accuracy between pre and post-TNT tests seen in Experiment 1.

Experiment 1 found that when participants attempted to recall contextual information that accompanied Think targets, they were less able to do so if the contextual information had also been adjacent to a No-think target. Further, this varied significantly between participants with high and low neuroticism. This finding is extended in the current, adjusted paradigm by including triads that feature multiple contextual items associated with the same TNT instruction. Contextual items associated with two Think targets were predicted to be recalled with the greatest frequency, and contextual items associated with two No-think targets to be recalled with the lowest frequency. The present experiment allowed participants to provide contextual information for targets that they were unable to accurately recall. That is, if a participant fails to correctly name a target, they still proceed to the second segment of the post-test trial wherein they see the correct target in the appropriate location and are tasked with recalling the surrounding items. This was predicted to increase the amount of contextual items participants are able to provide, compared to the relatively small amount provided in Experiment 1. To limit the potential for an inflation of false alarms, participants were discouraged from guessing the contextual items at random if they were uncertain.

Experiment 1 failed to produce a NCE in both the overall sample and in the neuroticism sub-groups. The aim of this experiment was to improve upon the design of Experiment 1 while striving toward the same goals: designing a TNT paradigm where a NCE is observed both for targets and for contextual information. If a NCE is observed for targets, contextual information, or both, the effect was predicted to differ between neuroticism groups.

Method

Participants. 42 University of Auckland students volunteered to participate in this study. Participants were compensated for their time with a 10\$ grocery store voucher.

Materials. Forty-five images were selected at random from the BOSS (Brodeur et al., 2010). The images were randomly organized into sets of three, further referred to as *triads*. At least one triad item was randomly associated with a cue-word. The cue-words used in this study were the same as in Experiment 1. Of the 15 triads, 9 featured two separate items that were each associated with a cue-word (i.e., dual-target triad, see Figure 3.3a, c) and the remaining 6 contained only one cue-target association (i.e., mono-target triad, see Figure 3.3b, d). Six dual-target triads contained competing TNT instruction targets (e.g., one Think target and one Baseline target), and 3 contained agreeing TNT instruction targets (e.g., two Think targets). This arrangement allowed for a total of 24 targets, and ensured that each TNT instruction category would have equal contextual item possibilities amounts. In all dual-target triads, the central triad item would remain unpaired; the central item served as a contextual detail for both targets. The TNT instructions associated with each target was counterbalanced between participants.

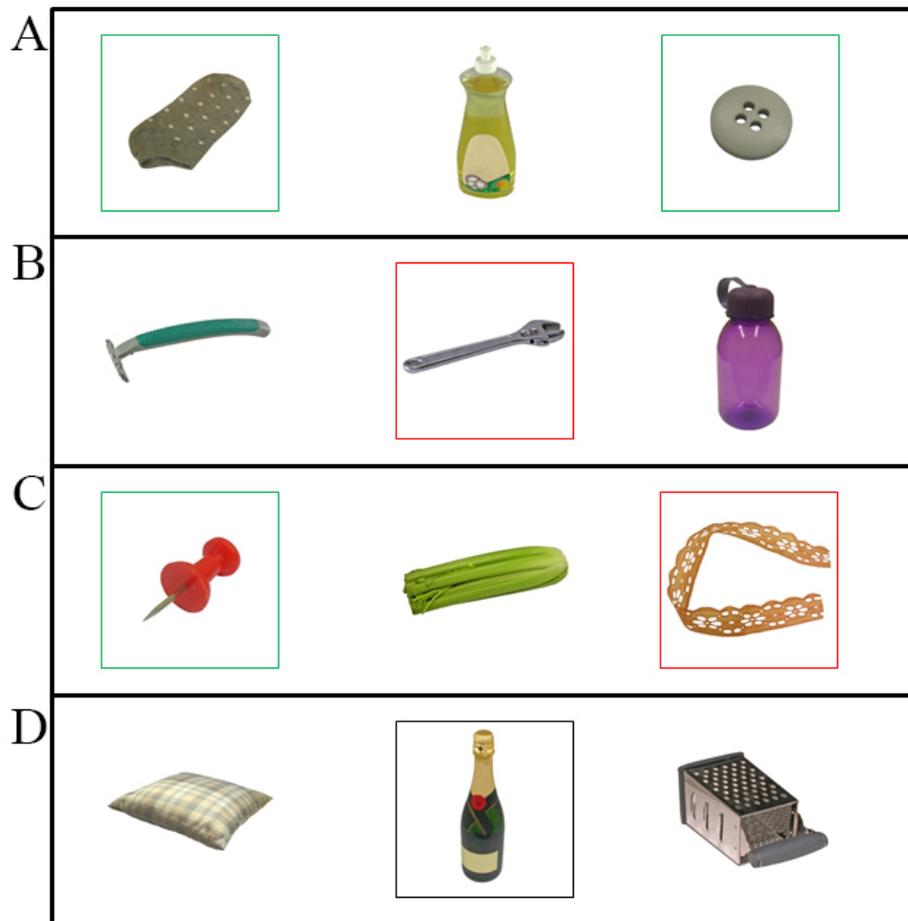


Figure 3.3 Four separate example item triads; a triad containing two targets of the same TNT instruction (a), a triad containing a single target (b), a triad containing two targets of competing TNT instructions (c), and a triad containing a single baseline item that would not be presented in the TNT phase (d). Think targets are denoted by a green border, No-think targets by a red border, and Baseline targets by a Black border. Un-bordered items are unpaired, contextual items.

Procedure. The experiment consisted of three phases.

Learning phase. Participants were shown each of the triads serially in a random order; dual-target triads were presented twice. Each item in the triads occupied 46% of the

total height and 43% of the total width of the monitor, and the triads were presented in the middle of the right half of the monitor. Participants were instructed to try and remember all of the items in the triad, and were given 10s to do so. The trial then continued for an additional 5s, wherein a cue-word appeared in the center of the left side of the monitor in a size 18 font, and the associated target item was surrounded with a distinct yellow border. Participants were instructed to remember the cue-target pairs as well as the whole of the triad, and that remembering both would be optimal for performance on a final memory test. After all 24 triad presentations were complete, a criterion learning test began. All 24 cues were presented serially, in a randomized order. The cues appeared in the same location on the screen where they were presented when they were paired with their respective targets, and in place of the triad items the numbers 1 through 3 were featured. Participants were given 10s, or until they pressed the enter key, per cue-word to type the name of the target item that had been paired with the cue. Participants were not required to indicate the spatial location of the target item or contextual associates at this point. Participants were required to reach a criterion accuracy score of 75% for target items before continuing to the next phase. If they were unable to achieve criterion, they repeated the learning phase.

TNT phase. Participants saw 16 of the 24 cues that had been paired with targets. Of the 16, 8 were designated as T cues, and 8 were NT cues. This was accomplished by presenting the cues in green and red, respectively. Participants were not given specific strategies on engaging in either T or NT trials, apart from the necessity of maintaining visual contact with the cues at all times. The designation of a cue as T or NT (or B by exclusion) was counterbalanced between participants. Each cue was presented 12 times, evenly over the course of four blocks of 48 trials, for a total of 192 trials. Each trial lasted 5s, featuring a

single cue word presented centrally in a size 18 font, with a 200ms ISI featuring a central fixation cross.

Testing phase. Participants were given 10s to respond to each cue word by typing the name of the target item. Following each target presentation was an additional 10s presentation of the target in the correct location within the matrix, and participants were instructed to respond by typing the names of the adjacent items. This occurred whether the target was correctly recalled or not, allowing participants to recall contextual items for targets they did not initially recall. The two items adjacent were not displayed at this point, and a number indicating the location within the triad (1, 2, or 3) was featured instead. Participants were discouraged from guessing, and instead encouraged to respond by typing a question mark if they were not certain which items were adjacent to the target. Unlike in Experiment 1, participants were not required to correctly name the target in order to subsequently provide names of items they believed to be contextual associates of the target. Participants were, however, encouraged not to randomly guess if they were entirely uncertain of the target's context.

Results

Of the 42 participants, 38 achieved the criterion level of accuracy within the allowed 3 attempts. Target accuracy scores represent the proportion of target items that participants correctly identified at post-TNT testing that had been correctly recalled at pre-TNT testing. Accurate and inaccurate contextual recall scores represent the average raw number of contextual items identified, regardless of whether the target was correctly provided.

Traditional Analyses.

Target Accuracy. Target accuracy was calculated, per participant, as the proportion of items recalled at pre-TNT that were subsequently recalled at post-TNT testing. See Figure 3.4 for a summary of raw accuracy means by TNT instruction category.

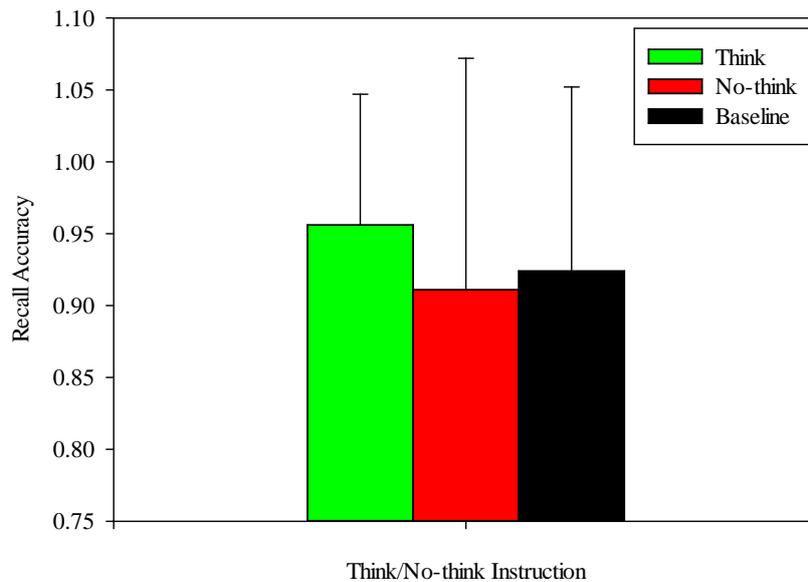


Figure 3.4 Raw post-TNT target recall accuracy scores by TNT instruction.

A repeated measures analysis was conducted for target accuracy scores across TNT instruction conditions. The difference between TNT instruction conditions was not significant [$F(1, 37) = 1.209, p = .304, \eta^2 = .032$], with accuracy decreasing from Think ($M = .956, SD = .091$) to Baseline ($M = .924, SD = .128$) to No-think ($M = .911, SD = .161$) targets. For target items correctly recalled at pre-test, TNT instructions did not significantly influence recall at post-test.

Accurate Contextual Recall. Overall accurate contextual item recall did not vary significantly between target TNT instructions [$F(2, 36) = .047, p = .954, \eta^2 = .003$]; without

considering the nature of secondary targets, participants did not recall more contextual items for Think, No-think, or Baseline targets. See Table 3.4 for accurate contextual recall means.

Three separate repeated measures ANOVAs were conducted on correct contextual recall for Think, No-think, and Baseline targets. Each analysis compared recall accuracy for contextual items of the main target when it was either unique to the target, or shared with a secondary target with Think, No-think, or Baseline instructions. These analyses were motivated by previous findings reported in this chapter, from Experiment 1.

Accurate contextual item recall did not vary between secondary target instruction for Think targets [$F(3, 111) = .987, p = .402, \eta^2 = .026$], No-think targets [$F(3, 111) = 1.437, p = .236, \eta^2 = .037$], or Baseline targets [$F(3, 111) = 2.180, p = .094, \eta^2 = .056$]. Overall, whether the contextual items were associated with only the main target or also an additional secondary target did not impact the amount of contextual items recalled when prompted to recall contextual items associated with each main target. These results did not confirm the hypotheses that contextual items associated with two Think targets would be recalled with the greatest frequency, and that contextual items associated with two No-think targets would be recalled with the lowest frequency.

Table 3.4

Mean(SD) Proportion of Contextual Items Accurately Recalled by Secondary Target

Category

Target	Unique	Think	No-think	Baseline
Think	.32(.84)	.26(.68)	.26(.72)	.42(.88)
No-Think	.37(.75)	.42(1.00)	.50(.98)	.21(.52)
Baseline	.26(.64)	.47(1.13)	.29(.61)	.50(1.08)

Revised Analyses. As in Experiment 1, a median split was performed to create neuroticism groups for analysis; low (Mean = 2.33, SD = 1.23; N = 19) and high (Mean = 7.88, SD = 2.26; N = 17). Both groups are marginally lower in neuroticism than the groups in Experiment 1.

Personality Inventory Relationships. To determine if the present sample demonstrated previously established relationships between RPSI responses and neuroticism, a one-way ANOVA was conducted on neuroticism scores between RPSI response groups. RPSI groups did not differ significantly on neuroticism scores [$F(2, 32) = .274, p = .762, \eta^2 = .017$]. Neuroticism scores decreased from Successful suppressors (M = 5.57, SD = 2.93; N = 7), to Non-suppressors (M = 4.63, SD = 3.79; N = 16), to Unsuccessful suppressors (M = 4.42, SD = 3.02; N = 12). These results do not conform to the previously observed relationship between RPSI responses and neuroticism, but inferences must be tempered by the relatively small group sizes involved in the analysis that resulted in relatively large within-group standard deviations.

Target Accuracy. A mixed design 2 (low vs. high neuroticism) x 3 (TNT instruction) ANOVA was conducted on accuracy proportion scores, calculated by dividing the number correct at post-TNT testing by pre-TNT testing scores for each TNT instruction category. The analysis showed a significant interaction between neuroticism and TNT instruction [$F(2, 33) = 3.351, p = .047, \eta^2 = .169$]. Separate repeated measures ANOVAs for low neuroticism [$F(2, 36) = 1.923, p = .161, \eta^2 = .097$] and high neuroticism [$F(2, 32) = 2.250, p = .122, \eta^2 = .123$] found that TNT instruction did not significantly affect target recall for either group, despite the previously observed interaction. Low-neuroticism participant accuracy decreased from Baseline, to Think, to No-think targets, while high-neuroticism participant accuracy

decreased from Think, to No-think, to Baseline targets (see Table 3.6). Although non-significant, accuracy scores trend in the predicted direction.

Table 3.6

Mean target accuracy proportion(SD) by Neuroticism Group and TNT instruction category

	Think	No-Think	Baseline
Low-neuroticism	.937 (.114)	.916 (.158)	.962 (.075)
High-neuroticism	.982 (.048)	.926 (.165)	.885 (.164)

Accurate Contextual Recall. Three separate mixed design ANOVAs were conducted to compare low and high neuroticism group correct contextual recall for Think, No-think, and Baseline targets. Each analysis compared low and high neuroticism group recall for correct contextual items of the main target that were either unique to the target, or shared with a secondary target with Think, No-think, or Baseline instructions. See Table 3.7 for descriptive statistics.

For Baseline targets, the interaction between neuroticism and secondary target instruction approached significance for accurate contextual item recall [$F(3, 32) = 2.839, p = .053, \eta^2 = .210$]. High neuroticism participant accurate contextual item recall varied significantly between secondary target instruction [$F(2.131, 34.092) = .043, p = .043, \eta^2 = .174$; Greenhouse-Geisser correction for violation of sphericity used], with accurate item recall decreasing from items shared with a secondary Baseline target, to a secondary Think target, to no secondary target, to a secondary No-think target. Accurate contextual item recall for Baseline target contextual items shared with a secondary Baseline target trended toward being significantly higher than accurate contextual recall for items shared with no secondary target ($p = .056$) and with a secondary No-think target ($p = .052$). Accurate contextual item

recall for Baseline target contextual items shared with a secondary Think target was significantly higher than accurate contextual recall for items with no secondary target ($p = .03$) and for items with a secondary No-think target ($p = .037$). Low neuroticism participant accurate contextual item recall did not differ between secondary target instructions [$F(3, 54) = .321, p = .810, \eta^2 = .018$].

For Think targets, accurate contextual item recall did not vary significantly as an interaction between neuroticism and secondary target [$F(3, 32) = 2.010, p = .132, \eta^2 = .159$] or as a main effect between neuroticism groups [$F(1, 34) = .137, p = .713, \eta^2 = .003$]. For No-think targets, accurate contextual item recall did not vary significantly as an interaction between neuroticism and secondary target [$F(3, 32) = 2.170, p = .111, \eta^2 = .169$] or as a main effect between neuroticism groups [$F(1, 34) = .157, p = .695, \eta^2 = .157$].

Table 3.7

Mean accurate contextual target (SD) recall proportion of total possible correct contextual items by target TNT instruction and secondary target TNT instruction for Low and High Neuroticism groups

	Target	Unique	Think	No-think	Baseline
Low-Neuroticism					
	Think	.16 (.50)	.42 (.83)	.42 (.96)	.37 (.95)
	No-think	.32 (.74)	.32 (.74)	.47 (.84)	.53 (.77)
	Baseline	.32 (.74)	.26 (.73)	.37 (.68)	.37 (1.01)
High Neuroticism					
	Think	.53 (1.12)	.12 (.48)	.47 (1.12)	.65 (1.36)
	No-think	.47 (.80)	.24 (.75)	.53 (1.17)	.06 (.24)
	Baseline	.24 (.56)	.65 (1.05)	.06 (.24)	.71 (1.21)

Discussion

The present study aimed to extend the findings of Experiment 1 with a simplified design, in an effort to increase the overall accuracy for target contextual information. Our results do not demonstrate a NCE for either target recall or contextual item recall. Although low neuroticism participant recall accuracy trended in the predicted direction, the observed NCE was not significant. Despite the simplified design of the present experiment, targets that were recalled at pre-TNT testing appear to have minimal forgetting regardless of TNT instructions (all TNT instruction level mean accuracies above 88% of pre-TNT accuracy levels). Furthermore, contextual items were recalled poorly despite explicit instructions to attend them in the initial learning phase. The low amount of contextual items recalled was not due to participants providing incorrect contextual responses in place of correct responses;

inaccurate contextual recall was rare. This has occurred despite our efforts to reduce the complexity of Experiment 2, relative to Experiment 1, with the goal of increasing the ease of contextual recall. Experiment 2 did, however, accomplish our goal of equalizing the potential amount of contextual items that could be recalled within each TNT instruction category. Nevertheless, if contextual recall were affected by TNT instructions, there were likely too few contextual items recalled overall for us to be able to observe a NCE in the present experiment.

Despite cueing participants to recall contextual items for targets, whether the targets were accurately recalled or not, we were still unable to elicit a suitable level of contextual recall. It is perhaps the case that if, as in Experiment 1, Experiment 2 had utilized a pre-learning phase (i.e., having participants learn the items of all item triads prior to pairing triad items with target words) then we would have seen a larger amount of contextual recall. This was not used in the present procedure in the efforts to reduce the overall recall of target items, which was also ineffective. Ultimately it appears that Experiment 2 may be an improvement over the method of Experiment 1, albeit admittedly flawed. That is, the participants found contextual recall to be marginally easier, as evinced by relatively increased amount of recalled contextual targets.

Chapter Discussion

The two experiments in this chapter have broached a subject that is novel to TNT literature. However, these exploratory paradigms were flawed in ways that likely prevent the observation of the impact of TNT instructions on items within a relatively complex environment (compared to targets that *are* a relatively complex environment; e.g., IAPS photographs, Depue et al., 2006, 2007). Further, in both experiments neuroticism was not

shown to be a crucial variable in detecting a NCE. We propose that the general lack of a NCE in these experiments was due to limitations inherent to the designs, as discussed below.

A critical limitation that would well be addressed in the discussion of the experiments of this chapter is emotional valence. In the two initial experiments presented here, we sought as much simplicity from the complicated design as possible and therefore did not introduce a manipulation of emotional valence. While emotional valence has been shown to be vital to eliciting a robust NCE (e.g., Noreen & MacLeod, 2013; Lambert et al., 2010), the earliest TNT literature found a modest but significant NCE without regard to manipulation emotional valence (Anderson & Green, 2001). Thus, although the early matrix TNT experiments presented in this chapter may be justified in the lack of emotion, emotional valence is virtually a mandatory addition to future investigations. Emotion can be introduced in to the matrix TNT paradigm in three, non-exclusive ways. Firstly, as Lambert and colleagues (Experiment 1, 2010) investigated with their word-pair paradigm, the emotional valence of the cues in the cue-target pairs may be manipulated. This manipulation would allow for the observation of the impact of TNT instructions on details, and the context of those details, surrounding emotional information. The emotional valence of the cues may inherently alter the memorability of the associated targets, which brings us to the second introduction of emotional valence: using emotional target items. Where studies using IAPS photographs as targets (Depue et al., 2006, 2007) capitalize on the emotionality conveyed by the entirety of the scene portrayed in the images, singular items within item matrices could be manipulated as well. It may prove somewhat more difficult to characterize a singular item as emotional, compared to using whole scenes *including* their context to elicit an emotional response. This is especially true if the contextual items adjacent to targets remain as emotionally neutral everyday objects, which are not overtly semantically related to the targets. However, exploring tropes of what is classically considered emotional may yield a BOSS-like set of

overtly emotional objects (e.g., a bloodied knife). Exploring this emotional manipulation would provide invaluable insight as to the impact of the suppression of emotional events on the contextual information of those events. An emotional event is rarely surrounded by exclusive non-emotional information, however, which brings us to the third introduction of emotional valence to the matrix TNT paradigm; using emotional items as context. This last manipulation would give an interesting look in to the memorability of emotional context for information that may not be inherently emotional. However, a paradigm that combines two, or all three of these emotional manipulations would be ideal.

Both experiments exhibited very high average recall accuracy for targets, relative to the amount of targets participants were able to recall pre-TNT. This is especially problematic for a TNT paradigm, insofar as the strength of suppression typically observed is usually quite low. That is, the items used in these experiments were so easy to remember that they were nearly impossible to forget. A speculative reason for the high degree of target recall in both experiments is that the BOSS items (Brodeur et al., 2010) are very easily communicated with a single word. In fact, this is relied upon for the memory assessments in both experiments. It is highly possible that rather than storing the cue-target pairs in memory as word-image pairs, these simple items were stored as word-word pairs. The target words would carry additional characteristics that would further cue target recall (e.g., bottle: water, purple, black lid, empty). However, separate and exclusive differences between paradigms may also have contributed to or resulted in ceiling level target recall. The procedure of Experiment 1 first had participants learn all 7 matrices to a criterion of 100% accuracy before moving on to cue-target pairing. This was our means of ensuring that participants attended to, and were able to recall the items that were not subsequently paired with cues. It may instead have resulted in over-familiarity with the subsequently paired target items, allowing for excellent target recall. However, if this element of the procedure resulted in excellent target recall, it is unclear as to

why it resulted in minimal (or often no) contextual item recall. One supposition is that after cue-target pairing participants avoided contextual item rehearsal (or suppression) in the TNT phase in favour of maintaining target accuracy. In Experiment 2, participants did not first learn all item triads to a 100% criterion, but were instead given the opportunity (accompanied by an explicit instruction) to attend to and learn all items within each triad for 10s immediately preceding the pairing of an item with a cue word. It is also worth mentioning that participants were expected to recall cue-target pairs to a 75% criterion before beginning the TNT phase in this experiment, whereas Experiment 1 only required a score of 50% to proceed. This was done in an attempt to increase contextual recall as well, but may have only increased target recall. Despite explicitly telling participants that remembering all members of the triads, not only targets, would benefit them on a later memory test, we still found high levels of target recall and low levels of contextual recall. Arguably, the high levels of target recall may be due to similar (speculative) issues as in Experiment 1; participants may simply abandon attempts at remembering contextual items in favour of targets. This may explain why both experiments exhibited very low average recall accuracy for contextual items. Where contextual recall was aided by forced pre-pairing rehearsal in Experiment 1, Experiment 2 relied on explicit instruction toward rehearsal without overtly testing to a criterion before the TNT phase. Neither of these mechanisms worked adequately, however, and we are left to ponder alternative approaches.

A likely step forward for the contextual TNT paradigms would be to increase the difficulty of correctly recalling a target on both criterion and final recall tests. As mentioned above, is it possible that the simplicity of the items used as targets allowed for participants to easily recall them. To be considered “correct” in naming an item, the participants usually only needed to provide a single word, much the same as a traditional word-word TNT paradigm (e.g., “bottle”). Adjusting the difficulty of being assessed as correct could be as

simple as requiring at least one (correct) adjective to accompany each target (e.g., “purple bottle”), or by increasing the number of items that constitute a single target. That is, to be considered a correct response, two target items would be needed to be provided. In the case of using triads of items, the third, non-paired item would constitute the contextual element. Of course, there exists a multitude of strategies that could be employed to adjust target recall difficulty while maintaining an item-matrix façade, and these are but two examples. The novelty of the item matrix TNT paradigm lends well to experimental creativity.

As for the desired increase in contextual item recall, perhaps it is the case that the pairing of target and context needs to be enforced more vigilantly. Where we presently have tested participants’ ability to provide targets in response to cue words to a certain criterion level, perhaps a similar test would be useful to ensure a criterion level of contextual association. In the triad TNT paradigm for example, a second pairing phase could be presented wherein participants are shown targets and their adjacent context item (dual-target triads) or items (single-target triads). Care need be exercised in the subsequent TNT phase to ensure that participants are solely focussing on suppressing or rehearsing targets, and not their contextual associates. In this way the vicarious effects of suppression and rehearsal may at last be observed on a contextual TNT paradigm.

Conclusion

Ultimately, while these two novel experiments in exploring vicarious suppression and rehearsal of contextual information yielded results that did not support our hypotheses, they have given us a wealth of information on how to proceed with future experimentation. A paradigm with more difficult targets, a larger focus on ensuring retention of contextual information, and ideally emotionally valenced stimuli is called for to further the exploration of the impact on memory for the context of suppressed information. Lastly, the data presented

here do not allow us to conclude whether neuroticism is critically involved in suppression of emotionally neutral information. However, further polishing the designs presented here may, in the future, help determine if neuroticism is involved in suppressing both emotionally valenced and emotionally neutral information.

Chapter 4: Imagined Event Think/No-Think Paradigms

In this chapter the effects of repeated suppression and rehearsal on memory recall for imagined autobiographical events and components thereof are examined. Findings from two experiments are presented, followed by analyses of a combined sample from the two experiments, comparing memory performance between groups differing in pertinent individual differences, as described in Chapter 2.

The present chapter endeavours to directly examine the impact of repeated suppressive attempts on memory for imagined events for the first time. Considering the emotional contexts surrounding both autobiographical memories and imagined events, it is prudent to examine the impact that emotional valence has on the differences between remembering and imagining. Just as autobiographical memories can be positive or negative, a future simulation may involve a windfall lottery winning or impending exam failure. Unlike autobiographical memories, however, novel future simulations have inherently not been subjected to repeated rehearsal or suppression. Though participants in Noreen and Macleod's (2013) paradigm were readily able to provide instance of autobiographical memories to be used as TNT targets, they also subsequently showed a reliable NCE for details of emotional autobiographical memories. Emotionally negative information has previously been found to be more vulnerable to suppression than information that is emotionally positive or neutral (Lambert et al., 2010; Depue et al., 2006; 2007; for emotionally valenced memories in general, Noreen & Macleod, 2013). Therefore, the memories that participants were reliably able to suppress across both experiments inherently contain at least one characteristic that may increase vulnerability to suppression. However, participants in the experiments reported by Noreen & MacLeod (2013) were indeed able to readily recall the memories provided in the experiment regardless of emotional valence. Perhaps it is not the case that the memories participants provided were not truly susceptible to suppression insofar as they were able to

recall them in the first place. That is, it is perhaps the case that the Noreen and Macleod (2013) paradigm failed to tap in to the set of memories most vulnerable to intentional suppression: those that are already suppressed. This is no critique of the method used to solicit participants to generate autobiographical memories in Noreen and Macleod's paradigm, rather an impetus to use equivalently ecologically valid, detailed, and self-referential stimuli that have not been previously rehearsed or suppressed. It would hardly be ethical to engage participants in such a way that induces their recollection of suppressed information; information that participants may have good reason to avoid recollecting. However, allowing participants to generate a novel series of emotional future simulations allows for the generation of highly valenced events that have not been exposed to either rehearsal or suppression.

Experiment 3

Susceptibility of emotional future simulations to forgetting has been examined by Szpunar, Addis, and Schacter (2012). Incorporating a manipulation of emotional valence, Szpunar and colleagues found participant accuracy to be lowest for emotionally negative simulations after a 24-hour retention interval. After only a brief 10 minute interval, however, memory performance did not vary by valence. While the interval between learning and testing is typically quite short in the TNT paradigm (~30 minutes), the interval is not spent passively. Instead, participants are actively and selectively rehearsing or suppressing the cue-target pairings and then typically complete an unrelated task prior to a final recall test. Previously, Noreen and Macleod (2013) had participants recall a series of emotional life events that were later paired with cue words and subjected to the TNT task. Rather than having participants remember experiences, the current experiment adapted the method used by Szpunar and colleagues (2012) to have participants imagine emotional future events that

would then be subjected to the TNT task. In this way, participants would be generating novel events that would inherently never have been previously rehearsed or suppressed, eliminating the possibility of previous rehearsal or suppression that comes with using autobiographical memories as TNT stimuli. Figure 4.1 represents the displays that participants were shown over the course of the experiment, excluding the post-TNT survey phase.

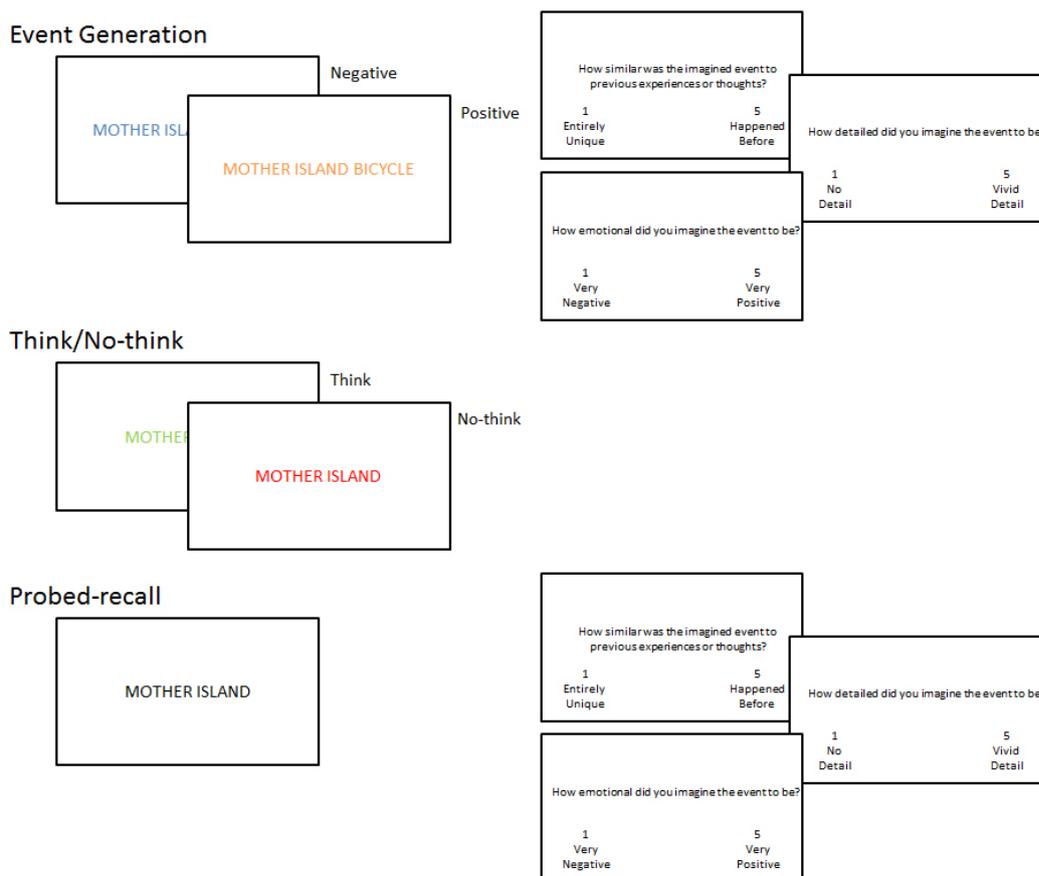


Figure 4.1 A graphical representation of the displays that participants were shown in the three phases of Experiment 3 concerning imagined events.

In considering previous evidence for a reliable NCE for negative valence no-think targets (Lambert et al., 2010; Noreen & MacLeod, 2013; Depue et al., 2006, 2007; Tesarek, 2008; Hertel & McDaniel, 2010), we predict to see a decrease in memory recall accuracy for negatively valenced targets associated with repeated suppression relative to all other target

categories. After repeated rehearsal of imagined events, Szpunar and Schacter (2013) found participants to report increased event detail and arousal compared to imagined events that were only rehearsed a single time. After a passive (i.e., no rehearsal instruction) delay, Szpunar et al. (2012) found no significant differences in phenomenological ratings between a brief and a long time interval. Therefore we predict that phenomenological ratings for events paired with Think instructions will differ from pre-TNT ratings, and that there will be no difference between ratings in the Baseline condition and pre-TNT ratings, collected at the beginning of the procedure.

Methods

Participants. Seventy-one University of Auckland students participated in the experiment during a laboratory session of a senior year Psychology course. Fifty-one participants (mean age = 21.73) successfully completed the paradigm while adhering to instructions (7 failed to reach a 50% accuracy criterion, 13 failed to adhere to instructions by either consistently averting their eyes from the display during the TNT phase despite instructions to maintain eye contact with the display).

Materials. The experimental paradigm was presented using E-Prime 2.0 software. Rather than using stimuli pairs as in past TNT experiments, stimuli sets consisted of 3 nouns (i.e., noun triads). A total of 25 generic noun triads were used; 1 practice triad and 24 experimental triads. Each triad contained a person, place, and an object (for noun triad members see Appendix Z). During the retention interval, participants also completed a survey package, including the Zimbardo Time Perspectives Inventory (Zimbardo & Boyd, 1999), the Neuroticism and Lie subscales of the Eysenck Personality Questionnaire - Revised (EPQ-R; Eysenck, Eysenck, & Barrett, 1985), and a brief inventory regarding suppression habits and

attitudes (Retrospective-Prospective Suppression Inventory; Ryckman & Lambert, 2015). Psychometric data from all three survey instruments is to be included in a larger dataset in Chapter 4 of this thesis.

Procedure. Participants were first exposed to the 25 noun triad trials. For each triad participants were instructed to imagine a future event, involving all three triad members, that could potentially occur within the next five-years. Further, participants were instructed that if the triad items were presented in blue text that the imagined event should be emotionally negative and that if the text was orange then the imagined event should be emotionally positive. The emotional valence instruction for each triad was counterbalanced between participants. All noun triads involved people, places, and things that are all commonplace in Auckland life. Triads were presented for 8s followed by a screen where participants provided a brief description of the imagined event, with an emphasis on providing as much detail as possible without worrying about grammatical structure (e.g., “on a tropical island with mother, rent bikes and explore the island, sunny day, picnic, friendly locals”). Participants had up to 30s to describe the imagined event, but could press the enter key to move on when they were satisfied with their description. Each trial concluded with three phenomenological ratings, made on a 5-point likert scale: (1) how similar the future event was to past experiences or thoughts, ranging from “the imagined event was entirely unique” to “the imagined event happened before”; (2) how detailed the future event was, ranging from “the imagined event has virtually no detail” to “the imagined event was as vivid as a memory for an actual experience”; and (3) how emotional the future event was, ranging from “the imagined event was extremely emotionally negative” to “the imagined event was extremely emotionally positive”.

In the subsequent TNT phase participants were provided with two members of a triad (triad-pair) in either red or green text, which were respectively associated with think and no-think instructions. For think trials, participants were instructed to mentally rehearse the non-presented triad member and the event that was imagined for the triad. For no-think trials participants were instructed to avoid thinking of both the non-presented target and the associated imagined event. Sixteen triads were represented in the TNT phase (8 think, 8 no-think). The 8 non-presented triads served as Baseline triads. Of the 16 triads in the TNT phase, 8 were emotionally positive and 8 were negative. Each triad-pair was presented 16 times over the course of 4 equal, randomized blocks for 4.5s per trial. Trials were separated by a 500ms ISI featuring a central fixation cross. Following completion of the TNT phase, participants were given 10 minutes to fill out the survey package. Lastly, participants completed a probed-recall test. Triad-pairs from all 24 triads were present in this phase. Trials in the final-probed recall test began with the presentation of a triad-pair for 8s, and participants responded by typing the appropriate target. Triad-pairs were presented in black text in this phase, precluding the colour of the text (blue or orange) from providing the emotional context for the triad. This was followed by providing the three phenomenological ratings for the pertinent imagined event as it was currently imagined. If participants could not recall the target the experiment moved on to the next trial after 8s. Phenomenological ratings were only included in the dataset for those trials where participants recalled the target item of the noun triad correctly.

Results

Recall accuracy. Participant accuracy was assessed according to the following criteria. If the target word was correct apart from a simple typographical error (e.g., *siblin* when the target was *sibling*), or if a more specific exemplar of the target was provided (e.g.,

brother for the target *sibling*) then it would be assessed as correct. Accuracy was determined by two independent markers (inter-rater reliability $r = .920$). Furthermore, inclusion of participants in our analyses was determined based on a 50% criterion accuracy score.

The accuracy with which participants recalled the third element of imagined autobiographical episodes, given the first two elements as cues, is summarised in Table 4.2. The prediction that recall of emotionally negative memories assigned to the *No Think* condition would be worse than recall of both rehearsed memories and Baseline memories was tested with a repeated measures analysis of variance comparing the accuracy of recalling negative memories in the three instructional conditions (*No Think*, Baseline and *Think* – see Table 4.2, left panel). The main effect of memory instruction was significant, $F(2,100) = 4.91$, $MSE = 13.596$, $p = .009$. Moreover, planned contrasts revealed that recall of negative memories in the *No Think* condition was reliably worse than recall of memories in both the *Think* condition ($t(50) = 3.12$, $p = .002$) and the Baseline condition ($t(50) = 1.73$, $p = .045$). The accuracy of recalling positive memories in the three memory instruction conditions (see Table 4.2, right panel) did not differ, $F(2, 100) < 1$, $MSE = .122$. In an omnibus analysis, the interaction between memory instruction and emotional valence approached statistical significance, $F(2,100) = 2.88$, $MSE = 7.597$, $p = .06$.

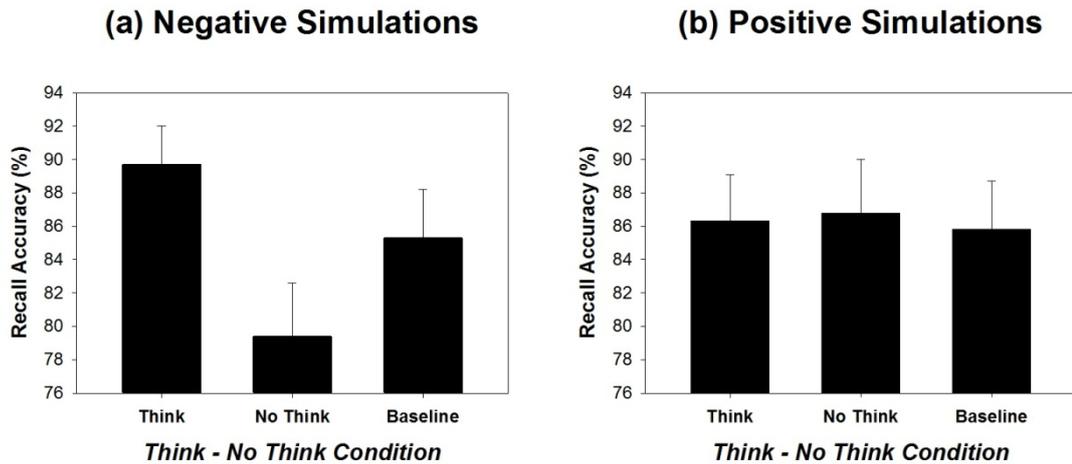


Table 4.2 Mean percentage of future events accurately recalled in the *Think*, *No Think* and Baseline conditions of Experiment 3. Error bars represent SE.

Phenomenological ratings. A Wilcoxon Signed Rank test was used to compare the non-parametric phenomenological data between pre-TNT and post-TNT rating instances. The analysis showed that ratings did not differ as a function of rating occasion or TNT instruction (all Z scores ≤ 1.484), so we collapsed ratings between rating occasions and TNT instruction category. Subsequent Wilcoxon tests showed that the differences between positive and negative valence target ratings were not significant for ratings of detail, but positive valence targets were rated as being more positively valenced ($Z = -6.096, p < .001$) and more similar to past experiences or thoughts ($Z = -3.975, p < .001$) than negative valence targets. Table 4.1 presents mean phenomenological ratings for positive and negative valence imagined events.

Table 4.1

Mean Phenomenological Ratings (Standard deviations) by Emotional Valence, Averaged between Testing Instances in Experiment 3

Emotional valence	Detail	Emotionality	Similarity
Positive	3.06 (.53)	3.62 (.36)	2.29 (.75)
Negative	2.96 (.60)	2.20 (.50)	1.87 (.57)

Discussion

The results of this experiment confirm our hypotheses that emotionally negative events are more susceptible to being suppressed than are emotionally positive simulated events. Our findings are in agreement with previous literature comparing the relative impact of TNT instruction on emotionally positive and emotionally negative stimuli (Lambert et al., 2010; Experiment 1, Noreen & MacLeod, 2013; Tesarek, 2008; Hertel & McDaniel, 2010).

In large part, our data resembles the pattern of accuracy presented by Szpunar et al. (2012) after a brief (10 minute) interval. That is, imagined events were largely recalled with ease across conditions. The exception to this pattern is the accuracy for emotionally negative no-think trials. Despite ostensibly similar suppressive attempts on emotionally positive counterparts, only emotionally negative no-think trials were reliably forgotten. The loss of accuracy for negative, but not positive no-think targets resembles the pattern of accuracy that Szpunar et al. (2012) observed after a long (24 hour) interval. While these results are in the predicted direction, a direct comparison of the present results with those of Szpunar and colleagues is precluded by the lack of an emotionally neutral condition. That is, the mechanisms of the active suppression (i.e., effortful and repeated) observed in the present experiment may be the same as the passive decay (i.e., not-effortful, due mainly to time elapsing) observed by Szpunar and colleagues.

Notably, our results display a NCE for emotionally negative imagined events but not for emotionally positive events. This finding mirrors one of the two experiments reported by Noreen and MacLeod (Experiment 1, 2013), where suppression for elements of emotionally negative autobiographical events was observed. The follow-up experiment (Experiment 2, 2013) found discrepant results; both emotionally positive and negative events were subject to a NCE. Noreen and MacLeod propose that the discrepancy between the results of their two experiments is due to the complex nature of their stimuli, and the variability of emotional

experience between participants. The discrepancy between the results in the current experiment and those of Noreen and MacLeod (Experiment 2, 2013) is possibly due to the overt difference in phenomenological similarity to past experiences and thoughts between emotionally negative and positive imagined events in the current experiment (see Table 4.1). Where the autobiographical stimuli that Noreen and MacLeod had participants provide are inherently self-relevant, albeit potentially influenced by the participants depth of recollection of each memory, our stimuli are dependent on the participants' ability to simulate novel events that have not been previously experienced. Emotionally negative imagined events were rated as being significantly less similar to past experiences and thoughts than were emotionally positive imagined events, which may indicate a general unwillingness to simulate emotionally negative events that relate to personal experiences. Alternatively, it may be the case that participants have a generally larger section of emotionally positive content in their mental libraries, increasing the likelihood of overlapping similarities with novel imagined events. Nonetheless, we did see reliable forgetting of negatively valenced no-think targets. If the decrease in recall for negative no-think targets was due to lower phenomenological similarity, we would expect a global decrease in negatively valenced target recall across TNT conditions that would not provide the reliable NCE that we observed. Furthermore, phenomenological detail ratings did not differ between valences; despite being less similar to personal experiences, positive and negative imagined events were perceived to have been simulated with similar subjective detail. This differs from the results reported by Szpunar et al. (2012), which showed imagined events to be rated as more detailed when the valence was positive, compared to negative. If a reduction in recollected detail contributes to forgetting of imagined events, then we would expect equivalent reports of detail for all levels of negatively valenced TNT instruction categories. This was not the

case, however, which suggests that phenomenological detail plays differing roles in target recall over time compared to after repeated suppressive attempts.

Although Addis and colleagues (2009) found simulating future and past events to rely on the same, imagining subsystem, this does not allow for the conclusion that the effects observed in the present study would inherently generalize to simulated pasts. In considering the results of the present study in conjunction with the similarities between past and future imagined events (Addis et al., 2009); a logical next step would be to compare the impact of TNT instructions on both imagined future and past events as a singular paradigm.

Experiment 4

Experiment 3 measured participant ability to effectively rehearse and suppress target items associated with imagined events. However, as the only measure of memory performance was the cued recall of the suppressed or rehearsed target, we were unable to draw conclusions regarding participant memories of the actual imagined events. Therefore, a critical addition to the measure of memory performance is having participants provide a description of the imagined event associated with each noun-triad at post-TNT test, in much the same as they provided the original description of the event, pre-TNT. Measuring participant recall accuracy for descriptions of the imagined events post-TNT will allow us to determine the impact of repeated suppression on participant recall of whole events, in conjunction with recall of singular target words. Further, we will also be able to compare the level of detail presented in the event descriptions between pre and post-TNT instances.

To capture the often relatively small degree of forgetting in the TNT paradigm, we employed a large sample. We predict that we will observe a NCE for imagined emotionally negative events, as in Experiment 3. Further, the similarity in neural mechanisms between

remembering the past, imagining the future, and imagining a fictitious past (Addis et al., 2009) support the further prediction that a NCE will be present for both imagined future and past events. However, as Noreen and MacLeod (2013) found different NCE patterns for emotionally positive and negative autobiographical memories between Experiments 1 and 2, it is possible that imagined pasts of both valences will be susceptible to a NCE.

A further benefit of using a large sample in the present Experiment is that comparisons can be made between participants who do and do not demonstrate a NCE. A NCE in a sample is often driven by a relatively small subgroup of the tested participants, which prevents comparisons between the subgroups of participants who do or do not demonstrate a NCE. Assuming a similar rate of participants demonstrating a NCE in the present sample as in Experiment 3 (36%), we will be able to compare phenomenological ratings between individuals who do or do not suppress targets. Although we saw no differences in phenomenological ratings between TNT conditions, it may be the case that subtle differences between TNT conditions existed only for individuals who demonstrated a NCE.

Methods

Participants. A total of 339 University of Auckland students participated in this study during a tutorial for an undergraduate Psychology course. Participants were given the option to exclude their data from analysis, and a large number of participants were excluded for failing to adhere to instructions, resulting in 217 usable cases.

Materials. The materials used in Experiment 4 were identical to those used in Experiment 3.

Procedure. The procedure was similar to Experiment 3, with minimal adjustments. Critically, this experiment manipulated the temporal direction of imagined events. Half of the participants were instructed to imagine events that could occur in the 5 years following participation in the experiment, and the other half were instructed to imagine events that could have occurred in the previous 5 years. Both conditions included explicitly instructing participants to imagine novel events, rather than recombine or re-imagine events that they had experienced or imagined previously. Phenomenological ratings in the present experiment were made on a 7-point likert scale, in order to determine if the ratings of Experiment 3 were potentially truncated due to the smaller, 5-point scale. Furthermore, during the final recall test participants provided both the triad target and a recount of the initial imagined event, followed by phenomenological ratings, allowing for qualitative comparison of event descriptions between the initial conception of the event and the post-TNT phase event description. Lastly, participants completed a Go/No-go (GNG) task. This was introduced both as a measure of executive functioning and a measure of behavioural adherence, allowing for the exclusion of participants who adhered to the experimental instructions poorly. The GNG task consisted of 200 trials. Each GNG trial began with a 200ms central fixation cross, followed by the presentation of a letter in place of the fixation cross, followed by a 500ms feedback screen. The letter presentation lasted a maximum of 2s, but ended as soon as the participant pressed the space bar. The goal of the Go trials (80% of trials) was to press the space bar as fast as possible in response to the presentation of one of 8 symmetrical letter cues (O, T, M, W, A, V, U, Y). The remaining 20% of trials were No-Go trials, featuring the letter X, where the goal was to avoid pressing the space bar. The feedback screen informed participants of the accuracy of the response for the current trial, as well as a cumulative running accuracy percentage. GNG results were used to determine participant engagement with the instructions of the experimental procedure.

Recall accuracy for targets was assessed in the same fashion as Experiment 3. Only one marker assessed the accuracy of responses in this paradigm, due to the degree of interrater reliability previously found. The marker was blind to target TNT instruction and emotional valence. Event description accuracy was assessed with similar, gist-based criteria as was recall accuracy. If both event description occasions contained the same general event then it was assessed as matching (i.e., correct); event descriptions were required to have the correct person, place, and object at post-TNT to be considered correct. If a participant had used a specific term at pre-TNT event description (e.g., “Matthew” instead of “my sibling”) then the event was judged correct if they again used the replacement term at post-TNT event description. It is crucial to note that events for that target nouns were not accurately identified may still be included in event description accuracy scores. That is, if participants fail to provide the appropriate target, they may still enter the event description if they remember it. However, they still must provide accurate gist descriptions of the event in question.

Results

Target Recall accuracy. A 2 (temporal direction of imagined event) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA was conducted on recall accuracy for targets; the third member of each triad that was not presented in the TNT phase. A three-way interaction was present [$F(2, 202) = 3.804, p = .024, \eta^2 = .036$]. Separate 2 (emotional valence) x 3 (TNT instruction) repeated measures ANOVAs were conducted for each temporal direction. Recall accuracy descriptive statistics are summarized in Table 4.2.

For imagined past events, a significant interaction between TNT instruction and emotional valence was present [$F(2, 196) = 3.369, p = .036, \eta^2 = .033$]. Subsequent repeated measures ANOVAs were conducted for each emotional valence. Emotionally negative

imagined event target recall varied significantly between TNT instruction categories [$F(2, 200) = 5.993, p = .003, \eta^2 = .057$]. Accuracy decreased from No-think, to Think, to Baseline target recall. Baseline accuracy was significantly lower than Think ($p = .034$) and No-Think ($p = .007$) accuracy. Think and No-think accuracy did not differ statistically. Emotionally positive imagined event target recall varied significantly between TNT instruction categories [$F(2, 204) = 5.570, p = .004, \eta^2 = .052$]. Accuracy decreased from Think, to No-Think, to Baseline target recall. Think accuracy was significantly higher than No-Think ($p = .014$) and Baseline ($p = .004$) accuracy. No-think and Baseline accuracy did not vary statistically. These results suggest that imagined events of fictional past events were not susceptible to the suppressive effects the TNT paradigm is known to elicit. Emotionally negative past imagined event targets were recalled above a Baseline level regardless of whether they were paired with a No-think or Think instruction. Emotionally positive past imagined event targets were better recalled when paired with a rehearse instruction, but were not recalled below a Baseline level when paired with a suppress instruction.

For imagined future events, recall accuracy varied significantly between TNT instruction conditions [$F(2, 210) = 9.762, p < .001, \eta^2 = .085$]. Accuracy decreased from Think, to No-think, to Baseline target recall. Recall for Think targets was significantly more accurate than for No-Think ($p = .001$) and Baseline ($p < .001$) targets, and No-think and Baseline accuracy did not statistically differ. This effect did not vary between emotional valences, and no main effect for emotional valence was present. These data show that future imagined event targets were better recalled when paired with a rehearse instruction, but were not recalled below a Baseline level when paired with a suppress instruction.

Table 4.2

Mean(Standard deviations) Target Recall Accuracy Proportion by Temporal Direction and TNT Instruction for Experiment 4

Temporal Direction	Valence	Think	No-Think	Baseline
Past	Positive	.889(.160)	.818(.225)	.813(.206)
	Negative	.843(.203)	.861(.182)	.770(.241)
Future	Positive	.868(.189)	.813(.226)	.769(.252)
	Negative	.884(.155)	.809(.211)	.827(.211)

Comparing negative target recall between Experiments 1 and 2. To determine if the lack of NCE replication from Experiment 3 to Experiment 4 was due to reliable differences between experiments, a final 2 (Experiment number) by 3 (TNT instruction) mixed design ANOVA was conducted on recall of emotionally negative imagined event target words. All participants from Experiment 3 and participants who imagined future events in Experiment 4 were included in this analysis. There was no significant difference in recall scores between experiments [$F(1, 158) = .222, p = .638, \eta^2 = .001$], and no significant interaction between experiment number and TNT instruction [$F(2, 157) = .420, p = .658, \eta^2 = .005$]. The main effect of TNT instruction remained present [$F(2, 316) = 9.290, p < .001, \eta^2 = .056$], with accuracy decreasing from Think, to Baseline, to No-think target recall accuracy (see Table 4.3 for TNT instruction means). Within-subject contrasts showed that Think recall was significantly more accurate than Baseline ($p = .012$) and No-think ($p < .001$) recall. No-think recall trended toward being significantly less accurate than Baseline ($p = .08$). These results indicate that both samples reflect the same pattern of results, which is trending toward an overall emotionally negative NCE.

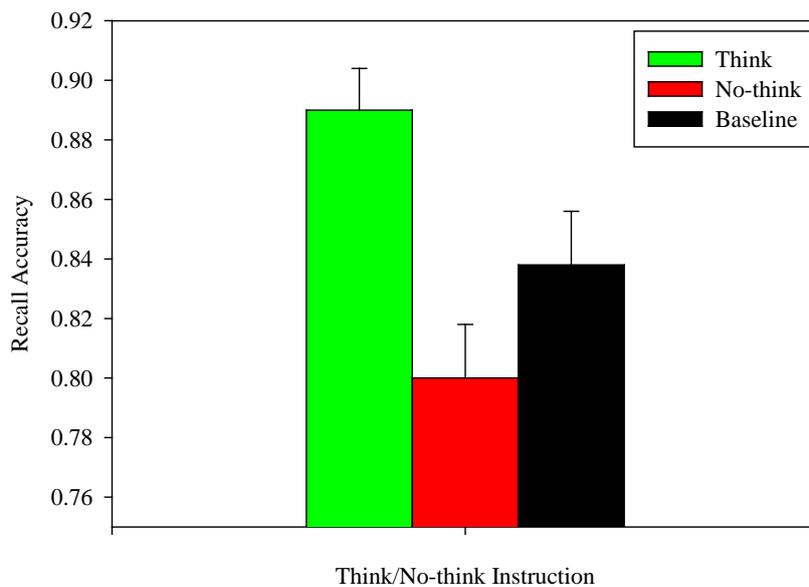


Table 4.3 Mean negative imagined event target recall accuracy for all participants from Experiment 3, and participants in the imagine-future condition of Experiment 4. Error bars represent standard error.

Event description accuracy. A 2 (temporal direction of imagined event) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA was conducted for event description recall accuracy scores. A main effect of TNT instruction [$F(2, 214) = 10.164, p < .001, \eta^2 = .091$] was present, with accuracy decreasing from Think, to No-think, to Baseline targets. Pairwise comparisons reveal that Think event descriptions were recalled significantly more accurately than Baseline event descriptions ($p < .001$). No-think event description accuracy did not differ significantly from Think ($p = .054$) or Baseline ($p = .059$) accuracy. No other main effects or higher order interactions were significant. These results clearly demonstrate a lack of NCE for imagined event descriptions, despite the presence of a rehearsal effect for Think targets. This pattern did not vary by emotional valence, or by

temporal direction of imagined event. Event description recall accuracy descriptive statistics are summarized in Table 4.3.

Table 4.3

Mean(Standard deviations) Imagined event Event Description Recall Accuracy Proportion by Temporal Direction and TNT Instruction for Experiment 4

Temporal Direction	Valence	Think	No-Think	Baseline
Past	Positive	.944(.126)	.914(.160)	.901(.178)
	Negative	.931(.166)	.939(.129)	.904(.166)
Future	Positive	.964(.094)	.912(.176)	.891(.182)
	Negative	.945(.142)	.927(.142)	.903(.181)

Phenomenological ratings.

Detail ratings. A 2 (temporal direction of imagined event) x 2 (rating occasion) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA was conducted. See Table 4.4 for category means. A main effect of emotional valence [$F(1, 203) = 15.286, p < .001, \eta^2 = .070$] revealed that emotionally negative imagined events ($M = 3.782, SE = .072$) were rated as being significantly less detailed than emotionally positive imagined events ($M = 3.937, SE = .070$). Emotional valence was not involved in any higher order interactions. While emotionally negative events were simulated with less detail than emotionally positive events, this did not vary between TNT instruction categories or between temporal directions. These data indicate an overall trend for emotionally negative events to be simulated in less subjective detail than those that are emotionally positive.

A significant interaction between rating occasion and TNT instruction [$F(2, 204) = 8.831, p < .001, \eta^2 = .101$] was further examined with separate analyses. Separate 2 (rating occasion) x 2 (emotional valence) repeated measures ANOVAs were conducted for each TNT instruction category, collapsing across temporal direction of imagined event, as past and future imagined events did not differ significantly in any of the omnibus comparisons. Think imagined event detail did not vary between pre-TNT and post-TNT rating occasions [$F(1, 204) = .529, p = .468, \eta^2 = .003$]. No-Think imagined event detail decreased significantly between pre-TNT and post-TNT rating occasions [$F(1, 204) = 15.860, p < .001, \eta^2 = .072$]. Baseline imagined event detail decreased significantly between pre-TNT and post-TNT rating occasions [$F(1, 204) = 12.225, p = .001, \eta^2 = .057$]. The difference in detail ratings for Think items did not differ between rating occasions suggesting that rehearsal did not increase subjective detail for imagined events; however, the decrease in No-think and Baseline detail suggests that rehearsal has prevented the decay of perceived detail. To determine if the decay observed in the No-think detail scores is due to passive or active (i.e., suppressive) mechanisms, detail ratings were averaged across emotional valences for No-think and Baseline imagined events for each rating occasion. These condensed detail ratings were then compared in a 2 (TNT instruction) x 2 (rating occasion) repeated measure ANOVA. The main effect of rating occasion [$F(1, 204) = 18.839, p < .001, \eta^2 = .085$] was preserved, but rating the effect did not interact with TNT instruction. With the lack of interaction between TNT instruction and rating occasion, we are unable to differentiate explanations between decay seen for No-think and Baseline imagined events.

Table 4.4

Mean(Standard deviations) Imagined event Detail Ratings by Temporal Direction, Testing Instance, and TNT Instruction for Experiment 4

Temporal Direction		Valence	Think	No-Think	Baseline
Past	Pre-TNT	Positive	3.96(1.16)	3.96(1.15)	4.04(1.24)
		Negative	3.87(1.19)	3.88(1.20)	4.01(1.30)
	Post-TNT	Positive	4.04(1.26)	3.77(1.21)	3.89(1.34)
		Negative	3.80(1.32)	3.69(1.25)	3.74(1.30)
Future	Pre-TNT	Positive	3.95(1.15)	3.99(1.11)	4.03(1.11)
		Negative	3.81(1.13)	3.79(1.12)	3.75(1.08)
	Post-TNT	Positive	4.08(1.20)	3.77(1.28)	3.76(1.23)
		Negative	3.80(1.29)	3.55(1.34)	3.69(1.28)

Emotional valence ratings. A 2 (temporal direction of imagined event) x 2 (rating occasion) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA was conducted. See Table 4.5 for category means. A main effect of emotional valence [$F(1, 203) = 754.019, p < .001, \eta^2 = .788$] confirmed that emotionally positive imagined events ($M = 4.909, SE = .046$) were rated as being significantly more positive than emotionally negative imagined events ($M = 2.840, SE = .048$), which were on the negative side of neutrality. These

results indicate that the paradigm manipulation of emotional positivity and negativity was effective in influencing the subjective emotional valence of imagined events.

The analysis indicated that TNT instruction did not significantly interact with emotional valence at any level, and did not have a main effect. Emotional valence did interact with rating occasion [$F(1, 203) = 11.439, p = .001, \eta^2 = .053$], with emotionally negative imagined events not significantly varying between rating occasions ($p = .2$) and emotionally positive imagined events decreasing in positivity, towards neutrality ($p < .001$). See Table 4.4 for means. These results indicate that emotionally positive imagined events were perceived as significantly less positive after the TNT interval, while emotionally negative imagined events were perceived as only marginally less negative after the interval.

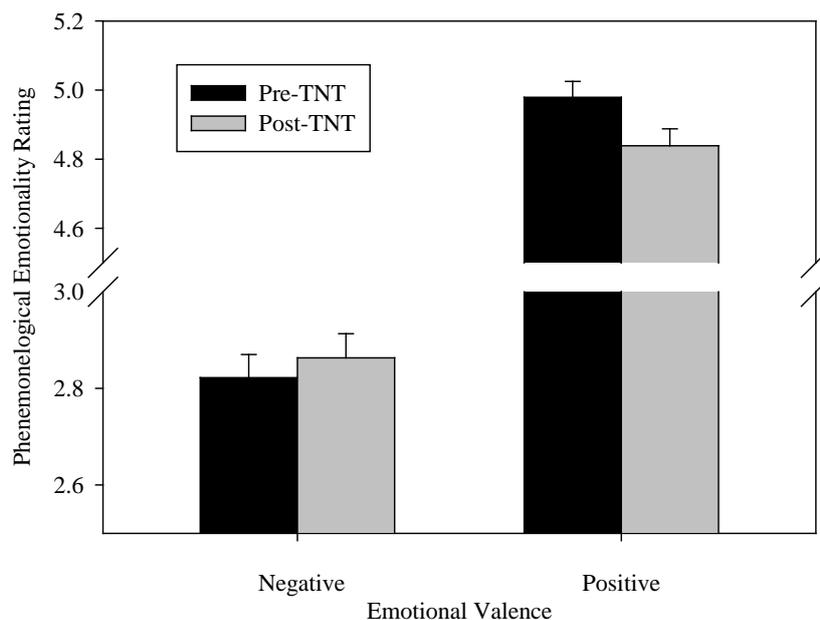


Table 4.4 Phenomenological emotionality means for emotionally negative and positive imagined events across rating occasions. Error bars represent SE.

Table 4.5

Mean(Standard deviations) Imagined event Emotion Ratings by Temporal Direction, Testing Instance, and TNT Instruction for Experiment 4

Temporal Direction		Valence	Think	No-Think	Baseline
Past	Pre-TNT	Positive	4.95(0.86)	4.92(0.81)	5.02(0.81)
		Negative	2.81(0.84)	2.94(0.86)	2.84(0.93)
	Post-TNT	Positive	4.90(0.86)	4.74(0.85)	4.79(0.87)
		Negative	2.96(0.98)	2.99(0.91)	2.90(0.93)
Future	Pre-TNT	Positive	5.01(0.91)	4.98(0.80)	4.97(0.86)
		Negative	2.79(0.86)	2.80(0.81)	2.76(0.92)
	Post-TNT	Positive	5.05(0.91)	4.85(0.95)	4.73(0.87)
		Negative	2.79(0.91)	2.76(0.81)	2.72(0.83)

Similarity ratings. A 2 (temporal direction of imagined event) x 2 (rating occasion) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA was conducted. See Table 4.6 for category means. A main effect of temporal direction [$F(1, 203) = 6.004, p = .015, \eta^2 = .029$] indicates that imagined events of an imagined future ($M = 2.397, SE = .100$) are rated as significantly less similar to previous thoughts or experiences than imagined events of an imagined past ($M = 2.750, SE = .103$). Temporal direction was not involved in any higher order interactions. A main effect of emotional valence [$F(1, 203) = 51.659, p < .001, \eta^2 = .203$] indicates emotionally negative imagined events ($M = 2.385, SE = .075$) are

perceived as being significantly less similar to previous thoughts or experiences than emotionally positive imagined events ($M = 2.762$, $SE = .078$). A main effect of rating occasion [$F(1, 203) = 10.202$, $p = .002$, $\eta^2 = .048$] indicates a significant decrease in similarity ratings between pre-TNT ($M = 2.636$, $SE = .069$) and post-TNT ($M = 2.512$, $SE = .079$) ratings. An interaction between rating occasion and emotional valence [$F(1, 203) = 5.865$, $p = .016$, $\eta^2 = .028$] was further examined with paired comparisons between rating occasions for each valence. Similarity ratings for emotionally positive imagined events decreased significantly [$t(204) = 4.121$, $p < .001$] from pre-TNT ($M = 2.846$, $SD = 1.124$) to post-TNT ($M = 2.668$, $SD = 1.211$) rating occasions. Similarity ratings for emotionally negative imagined events decreased marginally [$t(204) = 1.648$, $p = .101$] from pre-TNT ($M = 2.416$, $SD = 1.063$) to post-TNT ($M = 2.340$, $SD = 1.203$) rating occasions. While similarity ratings for emotionally positive imagined events were generally higher than the ratings for emotionally negative imagined events, emotionally positive imagined events significantly decreased in perceived similarity after an interval while emotionally negative imagined events only decreased marginally.

Table 4.6

Mean(Standard deviations) Imagined event Similarity Ratings by Temporal Direction, Testing Instance, and TNT Instruction for Experiment 4

Temporal Direction		Valence	Think	No-Think	Baseline
Past	Pre-TNT	Positive	3.08(1.37)	2.85(1.37)	2.98(1.43)
		Negative	2.53(1.31)	2.61(1.41)	2.58(1.47)
	Post-TNT	Positive	2.95(1.46)	2.77(1.33)	2.84(1.44)
		Negative	2.57(1.39)	2.62(1.48)	2.62(1.49)
Future	Pre-TNT	Positive	2.75(1.31)	2.73(1.22)	2.71(1.28)
		Negative	2.27(1.08)	2.25(1.16)	2.28(1.05)
	Post-TNT	Positive	2.54(1.35)	2.43(1.29)	2.51(1.29)
		Negative	2.13(1.12)	2.06(1.17)	2.10(1.16)

Discussion

The present sample did not demonstrate a NCE for either emotionally negative or emotionally positive imagined events, regardless of the temporal direction of imagination. Contrary to the results of Experiment 3, participants who imagined future events did not demonstrate a NCE for emotionally negative events. Contrary to the findings of Noreen and MacLeod (2013), participants who imagined past events did not demonstrate a NCE for emotionally negative events. It is possible that the subtle differences between neural

mechanisms involved in imagining and remembering past events contribute to the absence of a NCE for imagined past events. However, the lack of a replicated NCE for imagined future events suggests that while imagined events are susceptible to TNT based suppression (Experiment 3), the present paradigm did not capture this phenomenon. Furthermore, our hypothesis that suppression would impair recall of event descriptions was not confirmed. Apart from the additional between-subjects variable of temporal direction, the key deviation from the design of Experiment 3 in the present study was the addition of post-TNT event description recall. However, the analysis comparing negative imagined event target recall from Experiment 3 with future-imagining participants from Experiment 4 revealed no significant difference between paradigms. Therefore both samples reflect a similar pattern of results, but the increased sample size of Experiment 4 worked to weaken, rather than strengthen, the observed NCE for emotionally negative imagined future events. This similarity in patterns is despite the aforementioned differences between paradigms, and suggests that future paradigms exercise caution in exceeding appropriate sample size.

Phenomenology of imagined events was largely unaffected by TNT instructions, with no discernable differences between pre-TNT and post-TNT ratings of event detail or similarity. This finding does not differ from Experiment 3.

The next step is to reconsider the data presented here, as well as from Experiment 3, through the lens of individual differences: will our sample demonstrate differences in memory performance between groups divided in the personality traits that we found to be relevant in self-judgement of suppressive skills in Chapter 2? The following analyses build on previous literature that has demonstrated the importance of examining suppression through the lens of individual differences (Fawcett et al., 2015; Levy & Anderson, 2008; Bell, 2005).

Examining the Relationship between Neuroticism and Thought Suppression

Participants in Experiments 3 and 4 were tasked both with completing an iTNT paradigm and with completing a survey package that included the RPSI and EPQ-R N and L subscales. In compiling the data from Experiments 3 and 4, the actual suppressive capabilities of individuals who differ in their RPSI responses (i.e., non-suppressors, successful suppressors, and unsuccessful suppressors) and neuroticism scores can be effectively compared. Based on the differences between RPSI groups on measures of neuroticism, neuroticism scores were predicted to be highest in unsuccessful suppressors, decreasing to successful suppressors and non-suppressors.

Based on the survey results from Chapter 2, individuals who score on the higher end of the neuroticism spectrum were predicted to be unable to suppress No-think trial targets. As neuroticism is positively correlated with the experience of intrusive thoughts and rumination, which are often emotionally negative, it is possible that high-neuroticism individuals will experience a rebound effect for emotionally negative but not emotionally positive targets. Furthermore, individuals who are high in rumination have been previously found to be unable to suppress on the TNT paradigm (Fawcett et al., 2015). Due to the high positive correlation between neuroticism and rumination (Muris et al., 2005; Yoon et al., 2013; Ryckman & Lambert, 2015), it follows that high-neuroticism individuals will not be able to suppress. Successful suppressors and non-suppressors are predicted to have lower neuroticism scores than unsuccessful suppressors, but that is not to say they have *low* neuroticism. The successful suppressor and non-suppressor mean neuroticism (see Table 2.2) is nearly the precise middle of the EPQ-N subscale. Therefore, a medium level of neuroticism (i.e., mid-neuroticism) was predicted to be conducive to suppression. However, as the mid-neuroticism group will likely comprise successful suppressors and non-suppressors, they may not overtly demonstrate a NCE. That is, if RPSI groups are accurate in identifying their suppressive

tendencies and capabilities, then we will see a NCE in mid-neuroticism individuals who rate themselves as successful suppressors but not unsuccessful suppressors. No RPSI group is explicitly associated with low-neuroticism, which precludes directly predicting how these individuals will perform on a TNT task.

Participants

The sample in the present analyses comprises participants from Experiment 3 and Experiment 4. The participants included in this sample successfully completed the paradigm, all relevant personality measures, and consented to their data being used for multiple analyses. It was participant prerogative to not provide answers to questions on the RPSI if they wished, and so the sample size varies marginally according to the variables of interest per analysis. Cursory analyses demonstrated that the recall scores of the samples from Experiments 3 and 4 did not vary between experiments (see Appendix E).

Results

A cursory look at the present sample found that, if submitting the between-subjects variables of RPSI group, neuroticism, and temporal direction, sub-sample sizes were prohibitively small (e.g., future imagining, mid-neuroticism successful suppressors $N = 4$), despite our relatively large sample. To remedy this marginal limitation, analyses were conducted separately for RPSI groups and neuroticism groups.

RPSI Group Analyses. To determine if the present sample replicates the personality findings of the survey sample presented in Chapter 2, a Univariate ANOVA was conducted to compare neuroticism scores between RPSI groups. The analysis revealed that RPSI groups did not significantly differ in neuroticism scores [$F(2, 251) = 1.632, p = .198, \eta^2 = .013$], with

neuroticism decreasing from unsuccessful suppressors ($M = 6.90$, $SD = 3.00$; $N = 108$), to non-suppressors ($M = 6.45$, $SD = 3.26$; $N = 127$), to successful suppressors ($M = 5.77$, $SD = 3.13$; $N = 31$). The unsuccessful suppressors of the present sample maintain the highest neuroticism scores of the three groups, much like the sample of Chapter 2. However, the successful suppressors of the present sample demonstrate the lowest neuroticism; lower even than non-suppressors. The present sample does not reflect our previously established relationship between RPSI groups and neuroticism scores. The iTNT paradigms did not include the RRS, so we are unable to determine if RPSI groups in the present sample replicate RRS score differences as in Chapter 2.

RPSI group target recall accuracy was submitted to a 3 (RPSI group) x 2 (temporal direction) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA. RPSI demonstrated no main effect [$F(2, 248) = .196$, $p = .822$, $\eta^2 = .002$] or higher order interactions. This analysis demonstrates that target recall accuracy does not differ between RPSI groups, meaning that individual self-beliefs regarding suppressive capabilities do not reflect their performance on a laboratory suppression paradigm. However, taking the previous analysis in to consideration cautions this interpretation, as the neuroticism scores of the RPSI groups do not replicate previously established group norms. See Table 4.5 for RPSI group recall accuracy scores by TNT instruction.

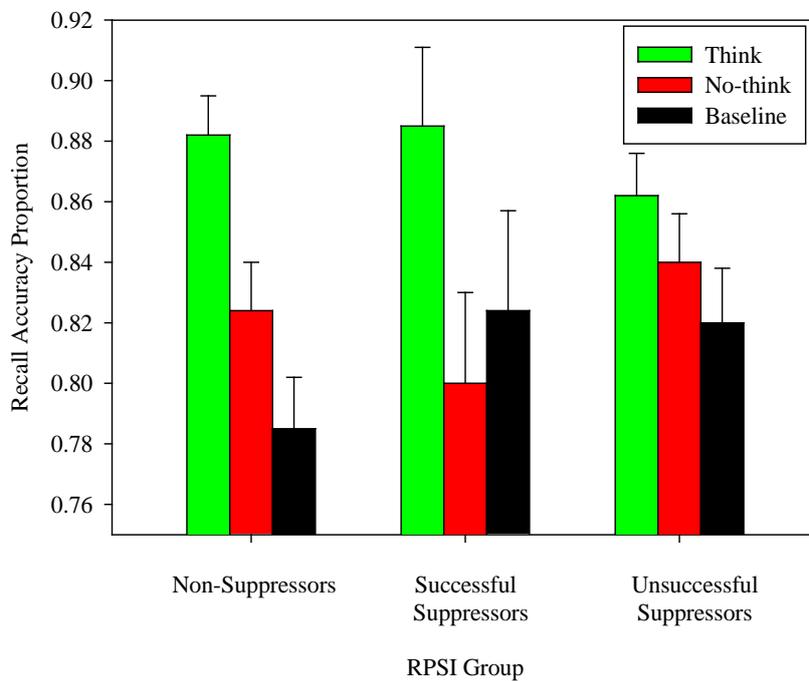


Table 4.5 RPSI group target recall accuracy scores by TNT instruction. Error bars represent SE.

Neuroticism Analyses. Participants were sorted in to one of 3 neuroticism groups by conducting a 3-way split that prioritized both group size equivalence and creating groups that reflected the mean neuroticism scores of the RPSI groups in Chapter 2: low-neuroticism ($N = 101$; $M = 3.34$, $SD = 1.47$), mid-neuroticism ($N = 51$; $M = 6.55$, $SD = .50$), and high-neuroticism ($N = 102$; $M = 9.77$, $SD = 1.38$). Group size disparity emerged due to clustering of participant scores along the EPQ-R neuroticism subscale; participants tended not to score in the lowest end of the scale, clustering participants toward the mid and upper ranges. This semi-clustered distribution, as shown in Table 4.6, necessitated one group to be of smaller size, and this was selected to be the mid-neuroticism group as to both condense the mid-

neuroticism group in to a truly “medium” sample of the participants tested in the experiments.

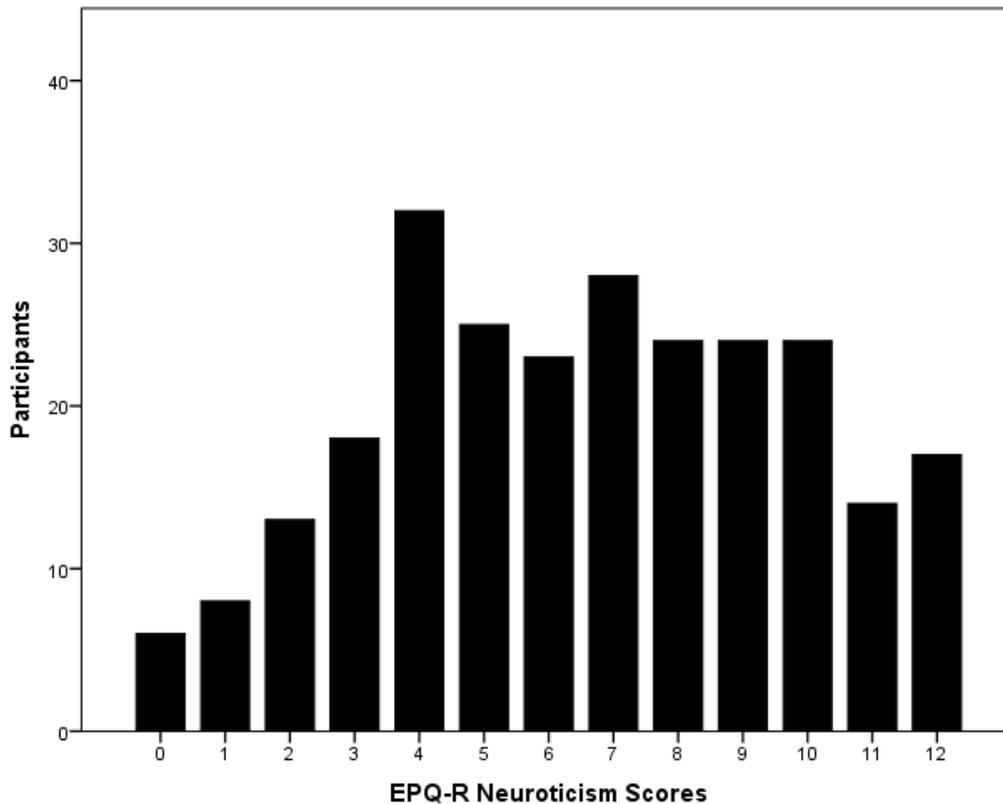


Table 4.6 Distribution of participant scores across the EPQ-R neuroticism subscale.

Target Recall Accuracy. Each neuroticism group was submitted to a 2 (temporal direction) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA. See Table 4.7 for descriptive statistics for recall performance by temporal direction, TNT instruction, and emotional valence for each neuroticism group. See Appendix F for a graphical representation of the numerical information presented in Table 4.7.

Low-neuroticism participant recall accuracy was significantly affected by TNT instruction [$F(2, 99) = 14.566, p < .001, \eta^2 = .227$], with accuracy decreasing significantly from Think to No-think ($p = .005$), and No-think to Baseline ($p = .01$). Think target recall was also significantly more accurate than Baseline recall ($p < .001$). These results indicate that low-neuroticism participants do not exhibit a NCE, but do exhibit a significant rehearsal

effect. However, as Baseline recall is significantly lower than No-think recall, which in turn is significantly lower than Think recall, low-neuroticism participants do not appear to be successfully intentionally suppressing or rehearsing No-think targets to the same extent as Think targets. However, No-think targets are recalled significantly better than Baseline targets, indicating that at least some rehearsal is occurring. This effect is irrespective of the emotional valence of the imagined events. See Table 4.7 for means and standard deviations pertaining to these analyses.

Mid-neuroticism participant recall accuracy was significantly affected by an interaction between TNT instruction and temporal direction [$F(2, 48) = 3.495, p = .038, \eta^2 = .127$]. Participants who imagined past events recall accuracy did not vary by TNT instruction [$F(2, 38) = .661, p = .522, \eta^2 = .034$]. Participants who imagined future events recall accuracy varied significantly by TNT instruction [$F(2, 60) = 9.017, p < .001, \eta^2 = .231$], with No-think recall accuracy being significantly lower than Baseline ($p = .001$) and Think ($p = .007$) recall accuracy. Think and Baseline recall accuracy did not vary significantly ($p = .119$). These results indicate that, irrespective of emotional valence, mid-neuroticism participants are able to suppress imagined future events but not imagined past events, having demonstrated a significant NCE. Further, Baseline and Think accuracy do not differ significantly, suggesting that mid-neurotic recall for imagined future events is not necessarily contingent on repeated rehearsal. See Table 4.7 for means and standard deviations pertaining to these analyses.

High-neuroticism participant recall accuracy was significantly affected by a three-way interaction between TNT instruction, emotional valence, and temporal direction [$F(2, 100) = 6.113, p = .003, \eta^2 = .109$]. To tease this interaction apart, separate 2 (emotional valence) x 3 (TNT instruction) repeated measures analyses were conducted for each temporal direction. See Table 4.7 for means and standard deviations pertaining to these analyses.

Imagined past event recall accuracy was significantly affected by an interaction between TNT instruction and emotional valence [$F(2, 74) = 4.465, p = .015, \eta^2 = .108$]. Emotionally negative imagined past events were significantly affected by TNT instruction [$F(2, 74) = 5.226, p = .008, \eta^2 = .124$], with No-think accuracy being significantly higher than Baseline accuracy ($p = .003$). No-think accuracy was marginally higher than Think accuracy ($p = .118$), and Think accuracy was marginally higher than Baseline accuracy ($p = .102$). Emotionally positive past event recall did not differ significantly between TNT instructions [$F(2, 74) = 1.482, p = .234, \eta^2 = .038$]. Imagined future event recall accuracy was significantly affected by TNT instruction [$F(2, 128) = 3.609, p = .030, \eta^2 = .053$], but not by emotional valence or an interaction between the two variables of interest. Recall accuracy decreased significantly from Think to No-think ($p = .031$) and Baseline ($p = .027$) target recall, and No-think and Baseline target recall accuracy did not differ significantly ($p = .874$). These results indicate that high-neuroticism participants were not able to suppress imagined events of either temporal orientation. Instead, when participants who imagined past events attempted to suppress emotionally negative events, they experienced a significant rebound effect; recall accuracy was higher for suppressed events than for rehearsed events. Participants who imagined future events did not experience a rebound effect for No-think targets, but were not able to suppress them below Baseline.

Table 4.7

Mean(Standard deviations) Target Recall Accuracy by Temporal Direction, Emotional Valence, and TNT Instruction for Neuroticism Sub-groups

Neuroticism Sub-group	Temporal Direction	Valence	Think	No-Think	Baseline
Low	Past	Positive	0.91(0.15)	0.82(0.22)	0.77(0.24)
		Negative	0.82(0.22)	0.80(0.20)	0.73(0.24)
	Future	Positive	0.86(0.19)	0.83(0.22)	0.76(0.26)
		Negative	0.90(0.15)	0.82(0.21)	0.79(0.24)
Mid	Past	Positive	0.86(0.19)	0.83(0.22)	0.80(0.19)
		Negative	0.85(0.22)	0.86(0.19)	0.83(0.22)
	Future	Positive	0.90(0.17)	0.83(0.20)	0.91(0.17)
		Negative	0.85(0.18)	0.77(0.21)	0.90(0.15)
High	Past	Positive	0.88(0.16)	0.82(0.24)	0.86(0.16)
		Negative	0.86(0.18)	0.92(0.14)	0.79(0.26)
	Future	Positive	0.85(0.21)	0.83(0.25)	0.78(0.24)
		Negative	0.90(0.15)	0.80(0.23)	0.85(0.20)

Event Description Recall Accuracy. Recall accuracy of participants from Experiment 4 was subjected to further analyses to compare the accuracy of recalling imagined event

descriptions between neuroticism groups. Each neuroticism group was submitted to a 2 (temporal direction) x 2 (emotional valence) x 3 (TNT instruction) mixed design ANOVA.

Low-neuroticism participant event description recall accuracy was significantly affected by TNT instruction [$F(2, 168) = 9.196, p < .001, \eta^2 = .099$], with accuracy decreasing from Think ($M = .944, SE = .012$), to No-think ($M = .914, SE = .015$), to Baseline ($M = .873, SE = .018$) imagined event descriptions. Baseline event descriptions were recalled significantly less accurately than Think ($p < .001$) and No-think ($p = .019$) event descriptions. Think event description recall trended towards being significantly more accurate than No-think event description recall ($p = .069$). No other variables of interest, or interactions thereof significantly affected imagined event description recall accuracy for low-neuroticism participants.

High-neuroticism participant event description recall accuracy trended towards being significantly affected by TNT instruction [$F(2, 160) = 3.034, p = .051, \eta^2 = .037$], with accuracy decreasing from Think ($M = .942, SE = .012$), to No-think ($M = .924, SE = .014$), to Baseline ($M = .903, SE = .017$) imagined event descriptions. Baseline event descriptions were recalled significantly less accurately than Think ($p = .022$) but not No-think ($p = .164$) event descriptions. Think and No-think event description recall accuracy did not differ significantly ($p = .260$). No other variables of interest, or interactions thereof significantly affected imagined event description recall accuracy for high-neuroticism participants.

Mid-neuroticism participant event description recall accuracy was not significantly affected by any variables of interest, nor higher interactions thereof. Unlike low and high-neuroticism participants, mid-neuroticism event description recall accuracy decreased from Think ($M = .965, SE = .017$), to Baseline ($M = .957, SE = .014$), to No-think ($M = .942, SE = .012$) imagined event descriptions.

These results show that suppression was not detrimental to participant ability to recall the descriptions of imagined events, regardless of neuroticism, temporal direction, or emotional valence. Rather, low and high-neuroticism participant event description recall was significantly higher for No-think events compared to Baseline, albeit a modest difference in recall proportion (4.1% and 2.1%, respectively). While mid-neuroticism participants recall accuracy was lower for No-think event descriptions than for Think and Baseline event descriptions, this pattern was not significant. See Table 4.7 for visual comparison between neuroticism groups by TNT instruction category.

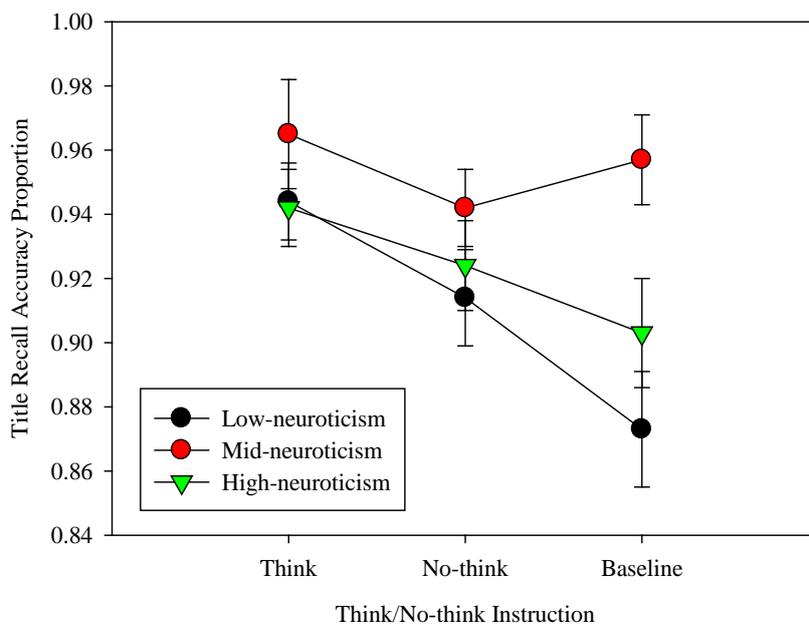


Table 4.7 Event description recall accuracy proportion by Think/No-think instruction and neuroticism group. Error bars represent standard error.

Phenomenological Results. Due to the general lack of interaction between TNT instruction and phenomenological ratings, each phenomenological trait was submitted to an omnibus 3 (neuroticism sub-group) x 2 (temporal direction) x 2 (testing occasion) x 2

(emotional valence) x 3 (TNT instruction) mixed design ANOVA as opposed to separate analyses for each neuroticism sub-group.

Detail ratings differed significantly as a 5-way interaction between all variables of interest [$F(4, 498) = 3.033, p = .017, \eta^2 = .024$]. To attempt to tease apart this complex relationship, a 2 x 2 x 2 x 3 mixed design ANOVA was conducted for each neuroticism sub-group. The 4-way interaction did not persist for low-neuroticism participants, though it did trend toward significance [$F(2, 99) = 2.911, p = .059, \eta^2 = .056$]. The 4-way interaction did not persist for mid-neuroticism participants, though it also trended toward significance [$F(2, 47) = 3.114, p = .054, \eta^2 = .117$]. The 4-way interaction did not persist for high-neuroticism participants [$F(2, 100) = 1.177, p = .312, \eta^2 = .023$]. These results indicate that while a complex relationship likely exists between the variables of interest and phenomenological detail ratings, it is not probable that this relationship is significantly affected by neuroticism.

Emotional valence ratings were not significantly different between neuroticism groups [$F(2, 249) = 1.287, p = .518, \eta^2 = .005$], and no higher order interactions involving neuroticism were present. These results indicate that the perceived emotionality of imagined events was not affected by our manipulations of interest, and this did not vary as a function of neuroticism.

Similarity ratings were not significantly different between neuroticism groups [$F(2, 249) = 1.718, p = .182, \eta^2 = .014$], and no higher order interactions involving neuroticism were present. These results indicate that the perceived similarity of imagined events to previous thoughts or experiences was not affected by our manipulations of interest, and this did not vary as a function of neuroticism.

Discussion

Our results indicate stark differences in suppressive capabilities between neuroticism groups. Low-neuroticism participants were not able to suppress target recall below a baseline level, but suppressed targets were not recalled as readily as events that are rehearsed. Mid-neuroticism participants were readily able to suppress imagined future event targets, but not imagined past event targets. High-neuroticism participants were not only unable to suppress targets, but experienced a considerable rebound effect for emotionally negative past event targets they have attempted to suppress. Furthermore, these patterns of results did not extend to recall of the descriptions of the imagined events. Participants did not demonstrate the ability to suppress memory recall of the descriptions of events.

Phenomenological ratings were not affected by TNT instructions, nor did they differ between neuroticism groups. This suggests that the differences in suppression capabilities observed between groups are not a product of differential phenomenology of events. That is, imagined events were not inherently perceived as more or less detailed, emotional, or similar to past thoughts or experiences by either low, mid, or high neuroticism participants. Therefore it can be concluded that the suppression, or lack thereof, observed in the present dataset was not due to inherent characteristics of memories that may influence memorability. Instead, it is likely that suppression was facilitated by cognitive mechanisms that are associated with neuroticism.

The relationship between suppression and neuroticism was not linear, however, as suppressive skills are most prevalent at mid-level neuroticism. It appears that while low-neuroticism and high-neuroticism participants were unable to effectively suppress, mid-neuroticism participants struck a balance between wanting to suppress and being able to suppress that the other two groups lack. That is, low-neuroticism individuals may not possess the anxious drive to forget undesirable or unwanted information, whereas high-neuroticism

individuals may possess this motivation but lack the ability to cease ruminating on the unwanted information. As neuroticism is highly correlated with rumination (Muris et al., 2005; Yoon et al., 2013; Ryckman & Lambert, 2015), and low ruminators are able to suppress whereas high ruminators are not (Fawcett et al., 2015), it is perhaps not surprising that high-neuroticism participants were unable to suppress in the present paradigm. Mid-neuroticism participants, on the other hand, would inferentially be placed toward the mid-range of rumination, as well. It is indeed possible that the low-rumination participants of Fawcett and colleagues (2015) covered the range of the ruminative spectrum that would house mid-neuroticism participants, therefore including participants most likely to be able to suppress. While the evidence at hand supports this conceptualization thus far, the underlying cognitive mechanisms were not in fact observed over the course of the present research, leaving this conclusion in the realm of informed speculation. Regardless of differences between neurotic sub-groups, however, it is clear at this point that emotional imagined events are indeed susceptible to intentional forgetting; but only if it is an imagined *future* and not *past*.

Chapter Discussion

In the results of the combined analyses we see that participants, even those predisposed to being capable of laboratory suppression, are unable to suppress recall for descriptions of imagined events. Although repeated rehearsal sporadically benefited event description recall in certain analyses, repeated suppression failed to reduce event description recall below Baseline levels in terms of both accuracy and level of detail. However, we also see that one sub-group of participants, the mid-neuroticism participant group, is particularly well suited for suppressing the targets that were most directly associated with cues-to-suppress. Being able to suppress elements that were used to generate imagined events, but not

the events themselves, leave us with an interesting question: is the imagining subsystem susceptible to suppression? The suppressed element was most certainly not imagined, as participants saw all three members of each noun-triad during the event generation phase, and phenomenological characteristics of the imagined events (that were inherently *also* imaginary) were not influenced by suppressive efforts. This is similar to the suppression of remembered, rather than imagined, autobiographical events (Noreen & MacLeod, 2013). Noreen and MacLeod (2013) found autobiographical scenarios to be generally recalled at a ceiling level if judged on a gist-understanding basis (i.e., the rater could easily determine that the provided information was pertaining to the original memory), but that suppressed memories tended to lack one or more components which were explicated to be necessary to participants (i.e., cause, consequence, and personal meaning). Therefore, it appears that imagined events of both past and future temporal direction and autobiographical memories are not vulnerable to wholesale TNT paradigm suppression. Rather, the degree of forgetting is limited to components of (i.e., Noreen & MacLeod, 2013) or components pertaining to (i.e., our results) episodic information. This conclusion suggests that, while neither are entirely susceptible to suppression, episodic memories and episodic imagined events are both susceptible to partial suppression. Therefore we can conclude that episodic information that is processed by either the remembering *or* imagining subsystems is similarly affected by suppressive efforts.

Limitations

The noun-triads used in the present study were designed to reflect commonplace people, places, and objects. However, although the places used were commonplace to life in Auckland, New Zealand, some participants may have been international exchange students or perhaps new to Auckland from elsewhere in New Zealand. Further, and almost inevitably,

some participants would have disproportionate familiarity with certain places, people, or things relative to other nouns they were exposed to in the imagined event phase and relative to other participants. Either one of these circumstances provide degrees of noise that would interfere with the data. This issue would be largely attenuated by having participants generate their own nouns. Previous literature has used participant-generated events to create recombined noun-triads with much success (Addis et al., 2009; Szpunar et al., 2012; Szpunar & Schacter, 2013; van Mulukom, Schacter, Corballis, & Addis, 2013). The exploratory nature of the present experiment lent well to the use of pre-determined noun-triads, as it greatly reduced the experiment participation time and allows for *en masse* testing.

Imagined events in the present study were reliably negative and positive in valence when the cue to simulate a negative or positive event, respectively, was presented. However, it is likely that participants are generally wary of simulating events that reach the polar ends of the negative valence spectrum. While repeated rehearsal of positive simulations increases phenomenological positivity, rehearsal of negative simulations does not increase phenomenological negativity (Szpunar & Schacter, 2013), further illustrating a general aversion to imagining severely negative scenarios. We suggest two options to increase the disparity of valence between negative and positive imagined events. Firstly, rather than using two valence cues (positive or negative) at the time of imagined event, participants could be trained to incorporate emotionality based on multiple, more descriptive cues (e.g., *happy, sad, ecstatic, traumatized*). Secondly, the inclusion of an instruction to generate emotionally neutral imagined events may help polarize imagined events paired with negative or positive valence cues. Without examining imagined events that are at more polar ends of a valence spectrum it is beyond the reach of the paradigm to generalize the results observed in this paper to the broader, more extreme range of experience. While laboratory stimuli may be less well remembered over time if they are negatively valenced, compared to positive (Holmes,

1970), Porter and Peace (2007) found that traumatic real-life experiences were more resistant to forgetting than their positive counterparts. Using imagined events, rather than having participants dredge up traumatic memories, allows for a less ethically troublesome look in to memory for trauma, and forgetting of elation.

The cues in the memory tests of Experiments 3 and 4 were components of the imagined events that were to be recalled (e.g., the person and place nouns, while the target is the object noun). The noun-triad stimuli were used in imagined event generation, suppression and rehearsal, and cued recall; every critical step of the experimental paradigm. As opposed to using a separate, semantically unrelated cue to refer to each imagined event as previous TNT research has done (e.g., Anderson & Green, 2001), the paradigms in the present chapter consistently reinforced the connection between noun-triads and the imagined event they were associated with. By using elements of the to-be-suppressed imagined event at virtually every step of the experiment, suppression may be circumvented by the inherent strength of the association between the cues to recall the imagined event and the imagined events themselves: all of the contextual information needed to support recalling the targets is provided by the cues. While a NCE was observed in the data presented in the present chapter, using the context of the target to cue recall of that target appears to be a highly effective mnemonic device despite suppressive attempts. Further exploration of the TNT paradigm using imagined events should be wary of using triad members to cue suppression and rehearsal. Instead, as done by Noreen and MacLeod (2013; 2014), it would be prudent to pair random cue words with each imagined event and use the random cue words as cues to suppress or rehearse.

Chapter 5: General Discussion

Overview of Thesis Results

Over the course of a survey study and four laboratory experiments, the findings presented in this thesis represent a significant and novel addition to the discourse of intentional thought suppression. Neuroticism is significantly related to self-reported frequency of thought suppression and personal beliefs regarding thought suppression use and efficacy, intrusive thoughts, and rumination (Chapter 2). Rumination is a significant variable in considering individual differences in performance on a traditional TNT paradigm using non-emotional stimuli (Fawcett et al., 2015), so it is critical to establish connections between similar variables to consider in thought suppression paradigms. Neuroticism and rumination both differed significantly between individuals who believe they unsuccessfully engaged in suppression in day-to-day life and those who believe they were successful in such suppression. However, the successful suppressors did not significantly differ in either neuroticism or rumination from individuals who did not believe they engage in suppression. The three groups did differ on the measure of experiencing intrusive thoughts, which increased from non-suppressors, to successful suppressors, to unsuccessful suppressors. While non-suppressors experienced relatively few intrusive thoughts, and unsuccessful suppressors experienced a relatively high amount of intrusive thoughts, successful suppressors mediated these two groups. In order to further investigate this phenomenon, and to determine if the successful suppressors are truly better at thought suppression than non-suppressors, participants were given a similar schedule of personality inventories as part of a novel TNT paradigm.

Neuroticism was found to be a key determinant in observing suppression of targets associated with imagined episodic events (Chapter 4); mid-level neuroticism was indicative

of the ability to suppress emotionally negative imagined future event targets, while high-level neuroticism was indicative of experiencing a rebound effect for emotionally negative imagined past event targets. The suppressor-types did not significantly differ in neuroticism in this sample. Thus, perhaps unsurprisingly, suppressor-types also did not differ in suppression performance. Furthermore, regardless of neuroticism, participants' phenomenological perception of their imagined events was not affected by suppression or rehearsal. Lastly, when the final memory test was modified to include a recapitulation of each imagined event, the gist-recall of imagined events was not affected by TNT instruction. While the connection between the different elements of imagined events (i.e., cues and targets) was affected by suppression, the gist content of the imagined events was typically recalled. These findings are similar to those of Noreen and MacLeod (2013), who found participants were able to suppress some elements of episodic memories, but not the gist recall of the memories overall. Unlike Noreen and MacLeod, the present research included the measurement of individual differences in neuroticism, which proved critical in the reliable observation of suppression.

Neuroticism does not, however, appear to be a significant determinant in observing non-emotional suppression of episodic memory, or of the contextual information thereof (Chapter 3). Furthermore, the TNT paradigm does not appear to be conducive to eliciting significant suppression of non-emotional items within a matrix of unrelated information, whether it is the key target associated with the suppression instruction, or the contextual information surrounding targets. The case may be that the two paradigms designed and tested in Chapter 3 would be functional with the additional manipulation of emotional valence, but at present the design appeared to be non-functional. However, as Fawcett and colleagues (2015) found rumination to be critical in suppression of non-emotional information on the

TNT paradigm, it may well be the case that rumination, rather than neuroticism, would have played a key role in detecting suppression in Experiments 3 and 4.

Detecting Suppression in Subsamples

As proposed by Levy and Anderson (2008), individual differences are an apparent factor involved in thought suppression; a functional TNT paradigm does not involve all participants being able to suppress. Rather, it is crucial to determine the factors that predict individual ability and willingness to successfully suppress information. Noreen and MacLeod (2013) found participants to be able to suppress details about events that they personally recalled from their own past experiences. The observed suppression was not permanent, however, as participants who returned for a follow-up study did not show reliable differences in memory recall between TNT instructions after a 12-13 month interval (Noreen & MacLeod 2014). Further, a second sample that was tested in the same fashion, but with a 3-4 month delay, and showed a similar pattern; the observed suppression is not permanent, nor particularly long-lasting. The samples that Noreen and MacLeod report (2015) do not ubiquitously demonstrate the ability to temporarily suppress elements of remembered events, and were divided in to groups of ‘good’ and ‘bad’ suppressors. To summarize, some individuals were able to suppress some details of remembered events for no more than 3 months. Perhaps much less than 3 months, as Meier, König, Parak, and Henke (2011) found participants generally able to recall previously suppressed targets from an emotionally neutral word-pair TNT paradigm after only a 1 week interval. This considerably brief span of suppression might seem lacklustre, as even before to the delay participants were able to provide accurate gist-recall for memories in which details had been (temporarily) forgotten (Noreen & MacLeod, 2013; 2014), barring a real-world example of when the brief suppression of a detail or item of context that is later remembered can have serious

repercussion. The memory for an emotionally negative real-world experience that an individual may repeatedly attempt to suppress, such as being an eyewitness to a violent crime, may become temporarily less detailed than the individual may later recall it to be (assuming the individual does not continue to suppress said memory over the course of the following months, which is empirically unexplored territory). Whether or not the eyewitness is able to suppress becomes critically important when the basis of judgement meted out to a potential perpetrator of the aforementioned violent crime is contingent on the eyewitnesses ability to accurately recall not the gist of the instance (i.e., a violent crime occurred), but a large amount of specific details associated with the instance (e.g., the identity of people involved, clothing, attitude, voice, weapons used, and further minute, potentially gruesome details ad nauseum). At this point it is crucial to determine if the details of a gist-recalled memory are impaired due to an individual being inclined to suppress emotionally negative experiences, and their constellation of individual differences that will determine their ability to engage in suppression.

Three critical variables to determining individual abilities in suppression have been discussed thus far in this thesis; executive control (i.e., the executive deficit hypothesis; Levy & Anderson, 2008), rumination (Fawcett et al., 2015), and neuroticism (Chapter 4). Each of these factors contains a level that benefits suppression (i.e., high executive control, low rumination, and mid-neuroticism, respectively). A variable heretofore unexplored in the current thesis that affects suppressive abilities is depression (Hertel & Gerstle, 2003); individuals who are depressed are typically unable to suppress. Depression is largely characterized by rumination (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), so the suppressive deficit in depressed individuals is perhaps unsurprising. However, as rumination is thought to result from deficient thought control processes (Joormann, 2005), and depression is associated with decreased executive control (Kaiser et al., 2003), it may well be

the case that rumination (and neuroticism, by proxy) and depression are the third variables of the executive deficit hypothesis. That is, while neuroticism, rumination, and depression have been found to affect suppressive capabilities, they are perhaps acting as indices of executive control instead of existing as variables that impact suppression. A prominent aspect of Levy and Anderson's (2008) argument for the executive deficit hypothesis is that individual suppressive abilities should be predicted by measuring variables that influence executive control, such as verbal and visual working memory span. Decreases in executive control associated with normal aging have also been associated with decreases in suppressive capabilities (Anderson et al., 2011), as Levy and Anderson (2008) predicted in the executive deficit hypothesis. Therefore the individual differences that have thus far been found to correspond with suppressive performance function as convergent support for the executive deficit hypothesis. Detecting suppression in subsamples may not be as arduous as applying a battery of personality inventories to participants engaging in TNT paradigms, but instead may be truncated by applying a measure of executive control. This is surely a critical notion to incorporate in to future investigations of the TNT paradigm, and ultimately an interesting question; do rumination and neuroticism predict the success of thought suppression in their own rights, or are underlying executive processes that predict both personality traits responsible?

Paradoxical Hyperavailability

When information is consciously suppressed it becomes paradoxically hyperavailable; it is remembered perhaps even more than information that was intentionally rehearsed. At least, that is what the famous White Bear suppression paradigm demonstrated (Wegner et al., 1987). The rebound effect that brought suppressed information to the forefront of conscious thought once active suppression was disengaged was widely replicated, and generally

accepted as an outcome of attempted thought suppression (see Wenzlaff & Wegner, 2000). However, the experience of intrusions of suppressed information from the White Bear paradigm is negatively correlated with working memory capacity; individuals with higher working memory capacity experience a smaller rebound effect (Brewin & Beaton, 2002). Directed forgetting research shows a similar pattern; retrieval induced forgetting (RIF) is positively correlated with working memory capacity (Aslan & Bäuml, 2011; Ortega, Gómez-Ariza, Román, & Bajo, 2012). A similar interaction was observed in the analyses of Chapter 4 that compared iTNT recall performance between individuals of varying neuroticism. Where mid-neuroticism individuals were readily able to suppress imagined negative past event information, high-neuroticism individuals experienced a rebound effect for the same stimuli. Where the White Bear paradigm has participants actively suppress information, a typical RIF paradigm has participants selectively and repeatedly rehearse stimuli pairings to the detriment of the unrehearsed pairings. The TNT paradigm combines these approaches by having participants actively rehearse *and* suppress stimuli, repeatedly. While the forgetting demonstrated by TNT participants endures for no longer than 3-weeks in most cases (Noreen & MacLeod, 2014), this is a great difference from the immediate rebound effect of the White Bear paradigm and the less-than-24 hour effect of RIF (MacLeod & Macrae, 2001). These three paradigms study ostensibly different formats of thought suppression, but having performance influenced by working memory performance and other related variables lends support not only to the executive deficit hypothesis, but to the similarity of underlying processes involved in varying types of forgetting. An important consideration for future endeavours regarding thought suppression would be to consider the similarities and differences between these three paradigms, and to consider how each approximates real-world suppression. Forgetting on all three paradigms is influenced by executive control,

suggesting that each paradigm offers at least a certain aspect that lends well to ecological validity.

Remaining at Least an Arm's Length from Repression

In the introduction of this thesis the issue of repression was discussed in only the most perfunctory of fashion, with the assurance that the remaining content of the thesis would remain at least an arm's length from the controversial topic. In order to reaffirm this claim we must, at last, breach the arm's-length barrier and address the matter directly. If repression exists in a fashion that at least *resembles* the outcome of the complete obliteration of a memory, perhaps approachable through miscellaneous psychotherapeutic methods, then suppression is not likely particularly related to repression, based on the evidence generated and literature discussed in this thesis. While some samples show up to a 60% NCE on the TNT paradigm (Levy & Anderson, 2008), this is a rare outcome and *still* not representative of the wholesale loss of episodic memory. As Kihlstrom (2002) explicates, TNT stimuli are simple in nature and, even so, are still not entirely forgotten. Paradigms using emotional stimuli show a larger degree of forgetting (Lambert et al., 2010) than many emotionally neutral TNT paradigms (see Levy & Anderson, 2008). As emotionally traumatic memories are the prime victim of repression, this finding supports Anderson and Green's (2001) original claim that the TNT paradigm demonstrated conscious control over mechanisms involved in repression. However, as Kihlstrom (2002) shrewdly observes, "it is doubtful that any of their subjects forgot that they had participated in a laboratory experiment" (pp. 502). That is, despite being traumatic perhaps in the sense of dullness, there is no wholesale loss of episodic memory involving the scenario in which information was suppressed. As seen in

Chapter 4 of this thesis, while pieces of directly-suppressed information associated with episodic events can be influenced by suppression (Experiments 3 and 4), the gist understanding of the events persists. Furthermore, where a repressed memory would be lost both in main event and surrounding contextual information (i.e., not only the traumatic car crash tableau, but also the time, place, and other relevant contextual information), Experiments 1 and 2 found no evidence that contextual information was reliably affected by the suppression of associated information. The stimuli used in all experiments in this thesis were arguably not classifiably traumatic, however. In truth no TNT paradigm can ethically expose participants to stimuli that would even approximate that trauma that is associated with the notion of repression.

However, a certain gap in literature could be filled in order to more directly compare repression and suppression. Insofar as repression was not necessarily a passive device, but rather the outcome of repeated and continual efforts to avoid information surfacing in conscious thought, a TNT paradigm that features a singular session of repeated rehearsal and suppression is perhaps not the best paradigm by which to compare suppression and repression. A paradigm such as the one developed by Noreen and MacLeod (2015) to test participant recall after a lengthy retention interval could be adapted. Rather than having participants come in to the lab for the initial session and, after an interval, the final recall session, participants could be brought in to the lab to engage in repeated suppression and rehearsal cycles at multiple times between the first and final lab session. In conjunction with the manipulations of emotional severity mentioned in the final discussion of Chapter 4, manipulating not only the emotional valence of stimuli but also the severity of the emotionality, this manipulation may provide a final note of insight into the similarity, or lack thereof, between TNT suppression and the controversial idea of repression.

In Conclusion

The research generated in this thesis approached thought suppression in a three-pronged effort. Firstly, the relationship between neuroticism, rumination, intrusive thoughts, and personal beliefs regarding thought suppression habits and abilities was elucidated. Secondly, imagined episodic events were found to be at least partially susceptible to laboratory thought suppression; more so for mid-neurotics than others. Thirdly and lastly, contextual information was not found to be particularly affected by suppression. By and large the evidence produced by this thesis serves to support the executive deficit hypothesis. All of the evidence produced here can be discussed without invoking the controversial topic of repression, leaving more room for the discussion of individual differences in thought suppression capabilities. The extent of the effect of repeated suppression of stimuli in a TNT paradigm has yet to come in to shape, but the research presented here suggests one avenue of fruitful future endeavours (imagined events) and one that perhaps requires some retooling to truly demonstrate utility (contextual paradigms). In conclusion, based on the conjunction of the evidence generated and literature discussed in this thesis, individuals are able to at least temporarily forget elements of emotional episodic memories, and not all individuals suppress equally.

Appendix A

The Retrospective-Pro prospective Suppression Inventory.

Question 1

In the past, when you have had experiences you wish to forget, did you consciously try to forget the experience?

Yes No Not Applicable

Question 2a (If question 1 is answered in the affirmative)

How did you consciously try to forget the memory of the experience?

Question 2b (If question 1 is answered in the negative)

What did you do to cope with the memory of the experience?

Question 3

In the future, if you experience something highly unpleasant, would you consciously try to forget the experience?

Yes No Not Applicable

Question 4a (If question 3 is answered in the affirmative)

How would you consciously try to forget the memory of the experience?

Question 4b (If question 3 is answered in the negative)

What would you do to cope with the memory of the experience?

Question 5

In your opinion, is trying to forget an unpleasant or undesirable experience a reasonable way to come to terms with an unchangeable event?

Yes No Sometimes No Response

Appendix B

Item matrices presented in Experiment 1. Yellow-borders signify items that were paired with TNT instructions. TNT instructions were counterbalanced between participants.





Appendix C

Accurate contextual response analyses for Experiment 1.

Separate analyses were conducted for accurate contextual responses comparing low and high neuroticism participants. Descriptive statistics for the following analyses are found in Table C.1.

A mixed design 2 (low vs. high neuroticism) x 3 (target proximity; unique, shared with No-think, shared with Baseline) ANOVA for Think target accurate contextual responses found that contextual recall trended towards differing significantly between proximity conditions differently for low and high neuroticism participants [$F(2, 34) = 2.940, p = .066, \eta^2 = .147$]. Low neuroticism ($N = 20$) participant contextual recall accuracy was significantly lower [$F(2, 38) = 5.965, p = .006, \eta^2 = .239$] for contextual items shared with No-think targets than for those shared with Baseline ($p = .018$) targets or that were unique to Think targets ($p = .003$). Recall for contextual items shared with Baseline targets and that were unique to Think targets did not differ significantly ($p = .237$). High neuroticism ($N = 17$) participant contextual recall accuracy did not differ significantly between target proximities [$F(2, 32) = .775, p = .469, \eta^2 = .046$]. These results show that, when prompted to recall contextual items for Think targets, low neuroticism participants recall fewer contextual items that had also been associated with No-think targets than if the contextual item had not been associated with a secondary target or had also been associated with a Baseline target. High neuroticism participants do not show this difference in contextual item recall.

A mixed design 2 (low vs. high neuroticism) x 3 (target proximity; unique, shared with Think, shared with Baseline) ANOVA for No-think target accurate contextual responses found that contextual recall trended towards differing significantly between proximity conditions differently for low and high neuroticism participants [$F(2, 35) = 3.121, p = .057, \eta^2 = .151$]. Low neuroticism ($N = 21$) participant contextual recall accuracy did not differ significantly between target proximities [$F(2, 40) = .124, p = .884, \eta^2 = .006$]. High neuroticism ($N = 17$) participant contextual recall accuracy was significantly higher [$F(1.480, 32) = 6.739, p = .009, \eta^2 = .296$; Greenhouse-Geisser correction for violation of sphericity used] for contextual items that were shared with Baseline targets compared to those that were unique to No-think targets ($p = .015$) or shared with Think targets ($p = .009$) targets. Recall for contextual items shared with Think targets and that were unique to No-think targets did not differ significantly ($p = .550$). These results show that when prompted to recall contextual items for No-think targets, high neuroticism participants recall more contextual items that had been also associated with Baseline targets than if the contextual item had not been associated with a secondary target or had also been associated with a Think target. Low neuroticism participants do not show this difference in contextual item recall.

A mixed design 2 (low vs. high neuroticism) x 2 (target proximity; unique, shared) ANOVA for Baseline target accurate contextual responses found that contextual recall did not differ between neuroticism groups or by target proximity, and the two factors of interest did not interact significantly (all $p > .3$).

Lastly, a mixed design ANOVA for total contextual response accuracy between neuroticism groups and between TNT instruction types found no significant difference in total accurate contextual items recalled between either TNT instruction category [$F(2, 36) = .340, p = .714, \eta^2 = .019$] or neuroticism group [$F(1, 37) = .332, p = .568, \eta^2 = .009$], and the variables did not interact significantly. Thus, TNT instruction did not affect the rate of overall accurate contextual item recall.

Table C.1

Mean accurate contextual target (SD) recall proportion of total possible correct contextual items by target TNT instruction and secondary target TNT instruction for Low and High Neuroticism groups in Experiment 1

	Target	Unique	Think	No-think	Baseline
Low-Neuroticism					
	Think	.186 (.225)	*	.025 (.047)	.118 (.149)
	No-think	.075 (.167)	.065 (.097)	*	.057 (.139)
	Baseline	.095 (.211)	.076 (.089)		*
High Neuroticism					
	Think	.066 (.123)	*	.036 (.059)	.070 (.134)
	No-think	.021 (.048)	.032 (.058)	*	.110 (.137)
	Baseline	.041 (.099)	.071 (.083)		*

Appendix D

Noun triads used in Experiments 3 and 4.

Person	Location	Object
TEAMMATE	BOOKSTORE	WATER BOTTLE
DENTIST	MALL	PEN
HAIRDRESSER	SWIMMING POOL	NOTEBOOK
BEST FRIEND	POLICE STATION	PIZZA
CAFETERIA STAFF	GOLF COURSE	FORK
MOTHER	ISLAND	BICYCLE
DOCTOR	HAIR SALON	JEANS
TEAMMATE	BOOKSTORE	WATER BOTTLE
DENTIST	MALL	PEN
HAIRDRESSER	SWIMMING POOL	NOTEBOOK
BEST FRIEND	POLICE STATION	PIZZA
CAFETERIA STAFF	GOLF COURSE	FORK
MOTHER	ISLAND	BICYCLE
DOCTOR	HAIR SALON	JEANS
UNCLE	AOTEA CENTRE	DIARY
GRANDFATHER	OFFICE	APPLE
SALESPERSON	LIBRARY	PHONE BOOK
HIGH SCHOOL TEACHER	CASINO	CAMERA
GRANDMOTHER	FOREST	CUP
AUNT	BEDROOM	TELEVISION
SIBLING	POST OFFICE	BLANKET
FATHER	BEACH	TABLE
COUSIN	LECTURE THEATRE	DOG
TEACHER	PARK	BACKPACK
TUTOR	AIRPLANE	BIRD
CLASSMATE	RESTAURANT	SUITCASE
FRIEND'S PARTNER	MOUNTAIN	SHOES
LECTURER	SCHOOLYARD	GLASSES
FLATMATE	BOAT	FLAG
FRIEND	KITCHEN	TEDDY BEAR
COWORKER	ART GALLERY	DRIVER'S LICENSE

Appendix E

Comparing sample characteristics between Experiments 3 and 4.

To determine if the lack of NCE replication from Experiment 3 to Experiment 4 was due to reliable differences between experiments, a final 2 (Experiment number) by 3 (TNT instruction) mixed design ANOVA was conducted on recall of emotionally negative imagined event target words. All participants from Experiment 1 and participants who imagined future events in Experiment 2 were included in this analysis. There was no significant difference in recall scores between experiments [$F(1, 158) = .222, p = .638, \eta^2 = .001$], and no significant interaction between experiment number and TNT instruction [$F(2, 157) = .420, p = .658, \eta^2 = .005$]. The main effect of TNT instruction remained present [$F(2, 316) = 9.290, p < .001, \eta^2 = .056$], with accuracy decreasing from Think, to Baseline, to No-think target recall accuracy (see Figure E.1 for TNT instruction means). Within-subject contrasts showed that Think recall was significantly more accurate than Baseline ($p = .012$) and No-think ($p < .001$) recall. No-think recall trended toward being significantly less accurate than Baseline ($p = .08$).

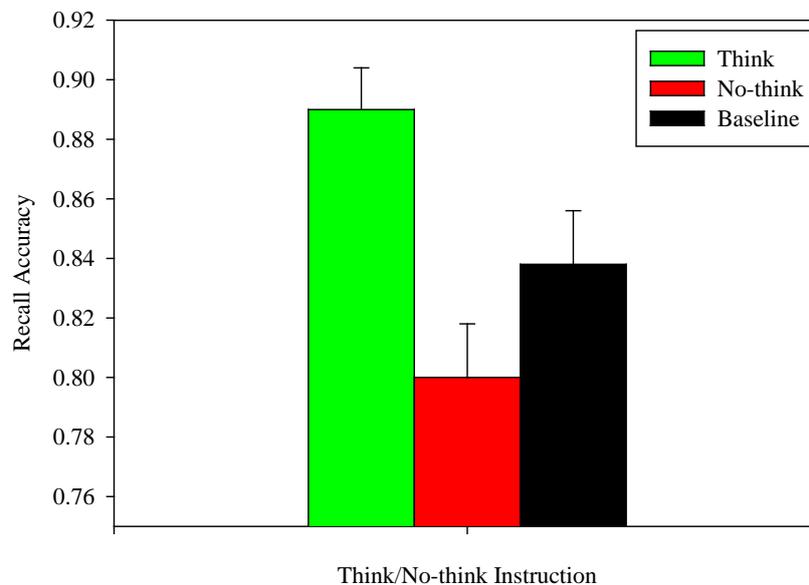


Figure E.1 Mean negative imagined event target recall accuracy for all participants from Experiment 3, and participants in the imagine-future condition of Experiment 4. Error bars represent standard error.

Appendix F

Graphical representation of the numerical data expressed in Table 4.7

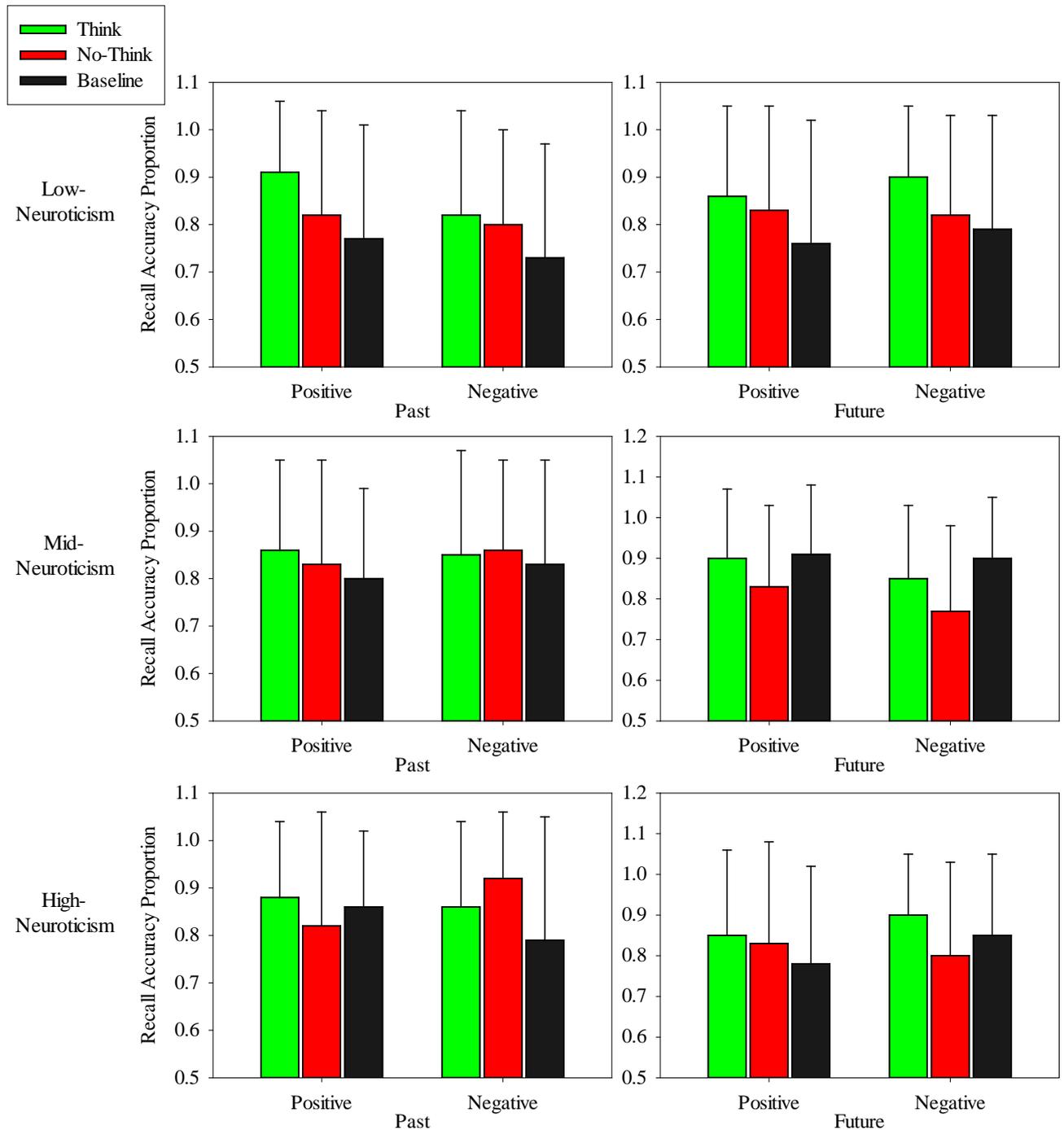


Figure F.1 Graphical representation of recall accuracy information presented in Table 4.7, group by TNT instruction, emotional valence, temporal direction, and neuroticism sub-group. Error bars represent standard deviation.

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