Suppression-Induced Forgetting And Depression

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Abstract

Anderson and Green (2001) were the first to show empirical evidence that actively suppressing certain memories in a Think/ No Think (TNT) Task might facilitate forgetting them, an effect called Suppression-Induced Forgetting (SIF). This effect has since been shown to decrease in the presence of depressive symptoms. The aim of the current study was twofold. It attempted to 1) replicate earlier research by finding evidence for SIF, and to 2) investigate how this effect is related to symptoms of depression. Within the TNT design, participants memorized cue-target word pairs and were subsequently instructed to respond to the cues by either recalling the corresponding target (Think) or suppressing the thought of the target (No-Think). The specific instructions for the No-Think trials depended on the condition of the participant, and consisted of either just avoiding the target while focusing on the cue (Thought Avoidance; TA), or responding with an earlier provided substitution word (Thought Substitution; TS). Participants were then subjected to two final recall tests of all target words, one using the same probes (SP) as in the previous phases and one using other, independent probes (IP). Depressive symptoms were measured with questionnaires.

The results showed a significant SIF effect in the SP condition, which was stronger in the TS condition than in the TA condition. No significant results regarding the IP condition were obtained. Additionally, no significant correlations between SIF and depression were found.

These mixed findings indicate that forgetting as a result of suppression seems possible, but they are inconclusive regarding the effect of using independent probes and the possible link with depression. Further research should focus on including IP tests, and using clinical as well as sub- and nonclinical samples.

Keywords: Suppression-Induced Forgetting, Depression, Rumination

Introduction

Memory and the way it can be influenced and manipulated has been a controversy-inspiring topic for many decades in the field of psychology. The debate over whether it is possible to selectively forget unwanted memories can be traced back to Sigmund Freud's writings on repression (Knafo, 2009). As he phrased it, "the essence of repression lies simply in turning something away, and keeping it at a distance, from the conscious" (Freud, 1957, p. 147; as cited in Knafo, 2009). Since Freud, many individuals have come forward claiming to remember parts of their past they had previously repressed, often including traumatic memories of sexual abuse, but the validity of these claims has been heavily debated (e.g. Gleaves et al., 2010).

Repression of unwanted thoughts as a coping style has been associated with negative health consequences, However, it also seems to be an effective way of avoiding the associated negative affect (Myers, 2010). How might repression and its conscious form, suppression, then relate to affect-related disorders, such as depression? This is one of the main questions asked in this thesis, which could provide more insight in symptom-reinforcing mechanisms within depression, and possible ways to disrupt these cycles.

Suppression-Induced Forgetting

Repression and its conscious form, suppression, have historically been difficult to empirically research. However, Anderson and Green (2001) devised an experiment that seems to be able to capture what is also called 'Suppression-Induced Forgetting' (SIF). In this design, participants first memorized a list of word pairs (e.g. ordeal – roach) in a way that would facilitate recalling the second word when seeing the first. These word pairs were subsequently divided in three groups: respond pairs, suppression pairs, and baseline pairs. In the TNT phase that followed, the participants were confronted with cue-words that required a different response dependent on the type of pair they were part of. In the respond trials, they

were instructed to vocalize the accompanying word to the cue (Think), but in the suppression trials they were instructed to avoid thinking about the associated word at all, while remaining focused on the cue (No-Think). Baseline pairs did not appear at all in this phase. After this task, all cue-words were presented again, but this time the participants were instructed to recall and respond with every target word regardless of the previous condition of the cue. Interestingly, the results of this final test showed that the target words that were part of the suppression pairs were recalled less often than those from the baseline pairs. This seems to indicate that suppression of the unwanted memories was at least partly successful (Anderson & Green, 2001).

Anderson and Green (2001) hypothesized that the mechanism behind this effect is based on inhibition. What they meant by this is that the intentional suppression of a target word directly affects the availability of the memory of this word itself, irrespective of its associations. However, SIF in their experiment could also be explained otherwise, for instance by a reduced strength of the association between cue and target, or the formation of other associations with the target-word. To account for this, they added a second type of memory test to determine recall of target-words. This test used independent probes (IP), comprised of a descriptive word and the first letter of the target-word (e.g. insect – r for roach). In this test, interference due to prior associations is eliminated, meaning that it is more likely that the SIF effect is explained by inhibition. In both the 'same probe' (SP) and the 'independent probe' (IP) conditions, Anderson and Green (2001) found significant SIF effects. Since these studies, more research has been done using this paradigm, which has largely replicated these initial findings (see Anderson & Huddleston, 2012 for a review).

Although the found SIF effects seem to imply that participants are generally successful in their attempts to suppress in the TNT task, this might not be an easy task for everyone. One variable that might account for some of the individual differences in SIF is the strategy that is

employed to suppress retrieval of target items. In their version of the TNT task, Hertel and Calcaterra (2005) distinguish between aided and unaided participants. In the unaided condition, no specific strategy for suppression was provided, but in the aided condition participants were given substitute words they could use to replace unwanted thoughts of the target-words. Their results revealed that, although both conditions showed SIF, this effect seemed to be larger for the aided group, which could imply that being provided with a clear strategy such as substitution is beneficial to forgetting in a TNT task (Hertel & Calcaterra, 2005).

Counter-Evidence for SIF

Although many studies seem to show significant SIF effects across conditions, these findings are not undisputed. In an effort to avoid publication bias, Wessel and colleagues (2020) published an analysis of several replications of studies using the TNT paradigm that were never published. Regarding the SP condition, mixed results were revealed, with some studies replicating the SIF effect, while others did not. Although this is not fully inconsistent with the available published data, it indicates that some caution in drawing strong conclusions might be warranted. More interesting, however, are the findings concerning the IP condition. Here, no conclusive evidence for the SIF effect could be found. This challenges the earlier described idea that direct inhibition of the target-words lies at the base of SIF (Anderson & Green, 2001; Anderson & Huddleston, 2012; Wessel et al., 2020).

More counter-evidence for Suppression-Induced Forgetting comes from a recent attempt at replicating the effect in an online format (Wiechert et al., 2023). In this study, no SIF effect was found, either in the SP condition or in the IP condition. However, as it was conducted online, the setting of the study differed markedly from earlier TNT studies, and was necessarily less consistent across participants. Therefore, it is difficult to identify to what degree the findings should be assigned importance.

In summary, there seems to be a lot of evidence for the robustness of SIF, but the contradictory evidence of some studies underscores the need for caution in drawing strong conclusions, especially regarding the IP condition.

Depression and Rumination

One of the main interests in this thesis is the association between memory suppression and depression. The diagnosis of depression as described by the DSM-5 (American Psychiatric Association, 2013) relies mainly on nine different symptoms on emotional, cognitive and physical levels. A symptom that is not specifically on this list, but has been strongly linked to depression, is rumination. Nolen-Hoeksema and colleagues (2008) describe this construct as a form of self- and symptom-focused attention that is negative and repetitive in nature, that could for instance include constantly thinking about a problem or a negative event without any productive outcomes. Rumination therefore plays a clear role in maintaining and increasing other depressive symptoms such as negative mood and concentration problems (Nolen-Hoeksema et al., 2008).

When comparing the definition of rumination to that of repression, or thought suppression, it seems apparent that the two are diametrically opposed: negative information is excessively dwelled upon in the former, and kept out of awareness in the latter. A plausible implication of this dichotomy might be that depressed individuals are less likely than non-depressed individuals to show Suppression-Induced Forgetting.

Much of the existing research on SIF focuses on healthy participants (e.g. Anderson & Huddleston, 2012). However, some studies have taken into account mental health variables. For instance, a meta-analysis about psychological disorders related to memory suppression found that, over all, depressed individuals show a smaller SIF effect than healthy individuals (Stramaccia et al., 2021).

Additionally, Fawcett and colleagues (2015) conducted a TNT task to investigate SIF, and additionally administered a measure of rumination. They found that rumination scores were negatively correlated with SIF, indicating that high ruminators are more likely to be impaired in their ability to successfully suppress. A logical thought might be that this relationship could be due to ruminative participants deliberately thinking about the No-Think items. However, this was found not to explain the correlation between rumination and decreased forgetting, which means that this relationship is more likely to reflect actual unintended deficits in SIF (Fawcett et al., 2015).

These findings seem to suggest that there is some element of mental well-being that needs to be intact for individuals to successfully suppress unwanted memories. In a study regarding working memory, Zetsche et al. (2012) showed that both depression and rumination are associated with a deficit in interference control, which refers to the ability to keep only relevant information in the working memory by inhibiting possibly distracting information. When considering the nature of the TNT task, in which the No-Think target words need to be kept out of the working memory, it seems logical that performance on this task would suffer from decreased interference control, which could explain the association between SIF and depressive symptoms. As inhibition of specific information is described as an integral part of interference control, it could further be argued that the effect should also be found when using independent probes.

In a similar way, Joorman and colleagues (2009) argue that depression-related impairments in the ability to control thoughts might lead to difficulties with consciously controlling the retrieval of unwanted memories during a TNT task. This cognitive control has in another study been identified as a necessary component of SIF (Chen et al., 2022). Joorman et al. (2009) further hypothesized that depressed participants might be helped by being provided with a specific strategy to suppress. Similarly to an earlier discussed study (Hertel &

Calcaterra, 2005), they therefore compared in their study participants that did not receive any aid with participants that were trained to use the specific strategy of using substitutes for the target words. Their results showed that the discrepancy between depressed and non-depressed participants regarding the SIF effect disappeared in the substitution condition.

Thus, it seems the deficits in forms of cognitive control in depressed individuals can be negated by adding more structure to the experiment.

Hypotheses

This thesis had a dual aim. It attempted to replicate earlier findings by investigating whether intentional suppression of learned target words in different conditions within a TNT task can lead to forgetting these words. It further aimed to study to what degree the presence of depressive symptoms might be related to this effect.

To this end, participants were confronted with cues from earlier learned word pairs. For Think items, they were expected to respond with the corresponding target word, and for No-Think items to either simply avoid awareness of the target word (TA) or respond with a substitute word (TS). Subsequently, recall for all Think, No-Think and Baseline items was tested, using both the Same Probes and Independent Probes). Depressive symptoms were assessed with questionnaires.

Based on the literature, it was expected that, in the present study, both an SIF effect and a positive control effect would be found in the SP- and IP-conditions, reflected by findings that (1A) No Think-items would be recalled statistically significantly less often than baseline-items, and, conversely, that (1B) Think-items would be recalled statistically significantly more often than baseline-items. According to an additional exploratory hypothesis (1C), those in the substitution-condition were expected to exhibit a significantly larger SIF effect than those in the avoidance-condition, in both the SP- and IP-conditions.

In line with the evidence regarding the relation between (symptoms of) depression and SIF, I expected that, in the avoidance-condition, participants scoring higher on measures of general depression and rumination would exhibit a statistically significantly smaller SIF effect than participants scoring lower on these measures. I did not expect this correlation to be found in the substitution-condition.

Methods

Transparency Statement

The data collection for this thesis was part of a multi-site research project. The anonymized data will therefore be shared with dr. Jonathan Fawcett, to be analyzed and stored alongside the data from other labs at the Memorial University of Newfoundland in Canada. Eventually, the data will become available on the Open Science Framework.

The data was collected in accordance with ethical guidelines, based on methods that were approved by the Ethics Review Board of Tilburg University.

No conflicts of interest were identified.

Participants

The final sample consisted of 47 first-year psychology students at the University of Groningen (8 male, 38 female, 1 other/not disclosed). They were between the ages of 18 and 26 (M = 19.55, SD = 1.56). Participants were recruited from the SONA participant pool, and received course credits in exchange for their participation. Only fluently Dutch speaking adults without color blindness were allowed to sign up to participate. In total, 58 participants were tested. Of these, one was excluded due to a failure to reach the required percentage (66%) of word-pairs learned during the learning phase. A further six participants were excluded after being identified as having cheated during the Think/No Think phase. This was determined based on three five-point questions (0-4) in the post-experimental questionnaire regarding any intentional thoughts of the original No Think targets during the TNT task. A

total score of 4 or higher constituted a cheater. Additionally, three participants were excluded because they did not sufficiently adhere to the instructions. One participant was excluded from analysis due to a technical error.

Design

The study used an experimental design with several independent variables. The condition of the word-pair (i.e. Think, No-Think, or Baseline) and the kind of cue used to elicit responses in the final test phase (i.e. same-probe or independent-probe) were both within-subject variables. The specific instructions received by the participants (i.e. Thought Avoidance or Thought Substitution) constituted a between-subject independent variable. The dependent variable in this study was the percentage of words that was correctly recalled in the final test phase.

Additionally, a correlational design was used to determine relations between SIF and depression and related symptoms. SIF was operationalized as the difference scores between No-Think and Baseline recall scores. Depressive symptoms were operationalized as the total scores obtained in the PHQ-9 and the RTQ-10.

Material

Word Lists

The word lists we used as stimuli in this study were based on those used by Benoit and Anderson (2012), and are comprised of 54 word pairs that have been translated into Dutch. The word pairs are divided into three lists of 12 critical items and three lists of 6 filler items. The condition (Think, No-Think, Baseline) assigned to each critical list was based on counterbalancing, the filler items were not counterbalanced. All critical word pairs and the No-Think filler pairs have an accompanying substitute word, and only the critical lists included independent test-probes for the target-words.

Post-Experimental Questionnaire

The Post-Experimental Questionnaire consisted of different measures for assessing adherence to the instructions, the strategies used during the Think/No-Think task, demographic information such as age and gender, and measures for different psychological symptoms, including depression, anxiety, repetitive thinking, sleep, and menstrual cycle.

As the current study is part of a larger project, not all questionnaires are relevant here. Importantly for this thesis, to measure depression, the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) was used. In this questionnaire, nine symptoms of depression are measured on a four-point scale (0-3). These are then added up to produce a total score.

To measure repetitive thinking, a construct related to rumination, the Repetitive Thinking Questionnaire (RTQ-10; McEvoy et al., 2014) was administered, which consists of ten symptoms of repetitive thinking measured on a five-point scale (1-5) that also add up towards a total score.

Procedure

Preparation For the Experiment

Prior to the start of the experiment, participants received information about the study and how the acquired data would be handled, after which informed consent was given. A language screener was verbally administered by questioning the participants' fluency in Dutch (either as a native speaker or with level C1 or higher). After this, the experimenter read out some background information about the aim and the importance of the study. Here, deception was used, as participants were at no point told that memory was the construct of interest. Instead, attention was presented as the important construct. Additionally, the participants were not informed about the different conditions they could be assigned to (TA or TS).

Learning Phases

In the first phase of the computer task, participants were presented with a series of word pairs comprised of a cue and a target (e.g. SPRONG – BALLET), that consecutively

appeared in the center of the screen. They were instructed to make a connection between these words. Immediately after, their knowledge of all word pairs was assessed in a test-feedback phase: when a cue word appeared on the screen, they had to verbally name the associated target word. After each trial, the correct answer was shown. This phase was repeated three times, or until the participant reached 66% accuracy of the critical trials on a run-through. This was followed by the criterion phase, in which the total amount of word pairs learned during the initial phases was determined. In this phase, otherwise the same as the test-feedback phase, no feedback was provided.

Participants in the Thought Substitution condition were then presented with substitutes for a subset of the target words (e.g. SPRONG – DOLFIJN instead of SPRONG - BALLET). This phase was absent for those in the Thought Avoidance condition.

Think/No-Think Phase

In the think/no-think phase, participants were again confronted with the same cue-words, excluding those that were by counterbalancing determined to be in the baseline condition. They could appear in either red or green text. If the cue-word was presented in green, the task was to verbally respond with the original target-word. For red cue-words, the instructions depended on participant condition, determined by counterbalancing. Those in the Thought Avoidance condition were told to think only of the presented cue-word, and to actively avoid thinking about the associated target-word. Those in the Thought Substitution condition were told to not only avoid thinking about the original target-word, but to replace it with the substitutes they learned. All responses were given verbally, while the experimenter used the keyboard to score them as correct or incorrect. Incorrect answers were followed by feedback on the screen in the form of the correct target- or substitute-word.

All relevant cue-words in this phase were presented twelve times, divided into six blocks. These were preceded by two short practice sessions with filler-words. Between the

two practice sessions, and between the third and fourth block of the actual TNT task, questionnaires were verbally administered to check participants' adherence to the instructions and to identify possible misunderstandings.

Context Reinstatement and Final Test Phases

Following the TNT phase, the participants were informed that their memory of the original target-words would be tested. First, in a short context reinstatement phase, meant to restore the mindset of the participant to that of the initial learning phases, the filler cue-words from the TNT practice sessions were presented one by one, and the task, similarly to the criterion phase, was to respond for each cue with the associated target-word.

The final test phase was divided into two parts. The Same-Probe test phase was identical to the context reinstatement phase, but was comprised of all critical items. In the Independent-Probe test phase, participants were again expected to respond with all the original target-words. However, this time they were presented with probes in the form of a new, related word accompanied by the first letter of the target-word (e.g. DANS – B for BALLET). The counterbalancing condition determined the order in which the two final test phases were presented to each participant.

Questionnaires and Debriefing

After finishing the computer task, the participants were asked to fill out the Post-Experimental Questionnaire, which consisted of different measures for assessing adherence to the instructions, the strategies they used during the Think/No-Think task, demographic information, and measures for different psychological symptoms.

Finally, the participants were briefly debriefed.

Method of Analysis

Before starting the analyses, variables were computed to denote the difference in recall between the No-Think trials and the Baseline trials, or the SIF effect, in the SP and the IP

conditions (hereafter called SPSIF and IPSIF respectively). This was done by subtracting the No-Think scores from the Baseline scores, meaning that a positive value denoted an SIF effect.

Further, control variables were computed for both the SP and de IP condition, that represent the difference in recall between the Think trials and the Baseline trials (SPControl and IPControl respectively). These were computed by subtracting the Baseline scores from the Think scores. Thus, a positive value here indicated a Control effect.

The scores that were used were conditionalized on the recall of words in the Criterion Phase, meaning that items that were not initially learned were not included in the scores.

To identify possible SIF and Control effects as predicted by hypotheses 1A and 1B, paired-sample t tests were conducted, and for exploratory hypothesis 1C, an independent sample t test was used. Finally, correlations between SIF and the depression-related scores were computed to test hypothesis 2.

Results

Main Analyses

Hypothesis 1A

To examine whether No-Think items were recalled significantly less often than Baseline items, a paired sample *t* test was conducted for both tests (SP and IP). In the SP condition, two outliers were identified using boxplots (see Appendix A), on opposite sides of the distribution. As they did not seem to skew the distribution and no obvious reason for their extremity was identified, they were judged to be valid data points and therefore not excluded. The *t* tests showed that, in the SP condition, significantly fewer No-Think items ($M = .88$, $SD = .15$) were recalled than Baseline items ($M = .97$, $SD = .07$; $t(46) = -3.98$, $p < .001$, Cohen's $d = .77$). The effect size of $d = .77$ indicates a moderate to large effect. In the IP condition, however, the difference between the No-Think items ($M = .79$, $SD = .12$) and the Baseline items ($M = .83$, $SD = .09$) was not significant ($t(46) = -1.53$, $p = .133$, Cohen's $d = .37$).

Hypothesis 1B

For the IP condition, a paired sample *t* test was conducted to examine whether Think items were recalled significantly more often than Baseline items. A boxplot revealed one outlier in the data (see Appendix A), but this was deemed a valid data point that did not seem to dramatically skew the distribution, and was therefore not excluded from the analysis. This *t* test did not show a significant difference between performance of the Think items (*M* = .80, *SD* = .10) and the Baseline items (*M* = .83, *SD* = .09; *t*(46) = -1.50, *p* = .14, Cohen's *d* = .31)

In the SP condition, a boxplot showed that the difference scores between Think and Baseline items (SPControl) were not normally distributed (Appendix A). This violates the assumption of normality for conducting a paired samples *t* test. To account for this, a non-parametric Wilcoxon Signed Ranks test was conducted, which showed that recall scores on Think items (*M* = .99) were significantly higher than the scores on Baseline items (*M* = .97; *Z* = -2.01, *p* = .045).

Exploratory Hypothesis 1C

To explore whether the instructions (Thought Avoidance or Thought Substitution) had a significant effect on SPSIF and IPSIF, independent samples *t* tests were used. For SPSIF, the *t* test revealed that those in the TS condition (*M* = .16, *SD* = .17) showed significantly more SIF than those in the TA condition (*M* = .02, *SD* = .11; *t*(45) = 3.39, *p* = .001, Cohen's *d* = -.98)

Regarding IPSIF, no significant effect of instructions on SIF was found (M_{TS} = .05, SD_{TS} = .15; M_{TA} = .02, SD_{TA} = .15; *t*(45) = .50, *p* = .617, Cohen's *d* = -.2)

Hypothesis 2

After first isolating the cases in which participants received TA instructions, the correlations between the two measures of SIF (SPSIF and IPSIF) and the total scores on the questionnaires for depression and repetitive thinking (PHQ-9 and RTQ-10 respectively) were

computed. No significant correlations were found (SPSIF – PHQ-9, $r(21) = .05$, $p = .824$; SPSIF – RTQ-10, $r(21) = -.15$, $p = .508$; IPSIF – PHQ-9, $r(21) = -.37$, $p = .082$; IPSIF – RTQ-10, $r(21) = -.03$, $p = .886$). Scatterplots visualizing these results are included in Appendix B

Subsequently, the same correlations were computed after isolating only the cases in which participants received TS instructions. Similarly, no statistically significant correlations were found (SPSIF – PHQ-9, $r(22) = .13$, $p = .539$; SPSIF – RTQ-10, $r(22) = .10$ $p = .632$; IPSIF – PHQ-9, $r(22) = -.11$, $p = .604$; IPSIF – RTQ-10, $r(22) = -.10$, $p = .641$). Visual representations of these results can be found in Appendix C.

Additional Checks and Analyses

As the participants were divided between three different researchers conducting the experiment, it was examined whether there were significant differences in the SIF and Control variables between experimenters, the presence of which could indicate experimenter bias. An Analysis of Variance (ANOVA) indicated that there was no significant effect of researcher on SPSIF ($F(2, 44) = 1.42$, $p = .254$), SPControl ($F(2, 44) = .071$, $p = .932$), IPSIF ($F(2, 44) = .28$, $p = .758$) or IPControl ($F(2, 44) = .01$, $p = .994$). Thus, no significant differences dependent on the experimenter were found. However, although the null-hypothesis was not rejected, neither was it definitely proven. This would require further testing, which is beyond the scope of this paper.

Additionally, participants were presented with one of three versions of the stimuli, in which the condition (No-Think, Think or Baseline) of each list of word-pairs was counterbalanced. To check whether the results varied depending on the version, an ANOVA was conducted for each outcome variable. No significant effects were found for SPSIF ($F(2, 44) = 2.39$, $p = .104$), SPControl ($F(2, 44) = 2.77$, $p = 0,074$), IPSIF ($F(2, 44) = .53$, $p = .595$)

and IPControl ($F(2, 44) = .22$, $p = .806$). Thus, the specific items that were in each condition did not significantly affect the SIF and Control effects

Finally, it was examined whether the order in which the final tests (SP and IP) were presented had an effect on the results, by conducting independent sample t tests comparing both conditions. This yielded no significant results for SPSIF ($t(45) = -1.20$, $p = .238$), SPControl ($t(45) = -.22$, $p = .826$), IPSIF ($t(45) = 1.09$, $p = .283$) or IPControl ($t(45) = .18$, $p = .858$). This indicates that being presented with either the Same Probes or Independent Probes first did not significantly affect the SIF or Control effects in these conditions.

To gain some insight in the degree to which the PHQ-9 (depression) and RTQ-10 (repetitive thinking) measure related constructs, a correlation was computed between the total scores on these questionnaires. A significant correlation of $r = .44$ (p < .001) was found, indicating a moderate association between the two questionnaires.

Discussion

Hypothesis 1: SIF Across Conditions

1A And 1B: SIF And Control Effects

One of the aims of this study was to replicate earlier findings of Suppression-Induced Forgetting (SIF), first operationalized by Anderson and Green (2001) as the difference in recall of items included in a No-Think task and Baseline items. Within the current design, it was hypothesized that a significant SIF effect would be found, for both Same-Probe (SP) cues and Independent-Probe (IP) (hypothesis 1A). The results are mixed. A significant SIF effect was found in the SP condition, but in the IP condition the analyses did not reveal a significant SIF effect. Thus, the hypothesis was only partly supported by the data.

A similar pattern emerged following analysis of the Control effects: Think items were recalled significantly more often than Baseline items in the SP condition, but not in the IP

condition. The hypothesis that a Control effect would be found in both conditions (1B) was therefore also only in part supported.

The findings regarding the SP condition are in accordance with the general outcomes of previous research on this topic (e.g., Anderson & Green, 2001; Anderson & Huddleston, 2012)

As no significant SIF effect was found in the IP condition, the results on this front are inconclusive. This seems less in line with the general findings (e.g., Anderson & Green, 2001; Anderson & Huddleston, 2012). However, relatively few studies seem to have used IP in their designs. For instance, in their meta-analysis of a subset of TNT studies (only those including measures of psychological disorders), Stramaccia et al. (2021) found that only four out of a total of 25 studies included an IP condition. The available evidence for SIF based on Independent Probes is less conclusive than that for SIF in SP conditions. Thus, future research will need to focus on including Independent Probes in TNT designs.

1C: Thought Substitution Versus Thought Avoidance

The results further showed that the degree of SIF displayed in the SP condition was dependent on the instructions participants received, with Thought Substitution being associated with a larger SIF effect, as predicted in exploratory hypothesis 1C. Again, the part of the hypothesis concerning the IP condition was not supported, as here no significant difference in SIF was identified between the TA and TS conditions.

The SP results, similar to those found by Hertel and Calcaterra (2005), showed that SIF benefits from a strategy such as Thought Substitution during the TNT task.

Hypothesis 2: SIF And Depression

Another aim of this study was to examine the association of depression and related symptoms with the SIF effect. The PHQ-9, which is a measure for depression (Kroenke et al., 2009), was not found to correlate significantly with SIF, regardless of the kind of probe used

or the specific instructions (TA or TS) received. Similarly, no statistically significant correlations were found between SIF and the RTQ-10, which measures repetitive thinking, a construct related to rumination (McEvoy et al., 2014). As it was predicted that, in the TA condition, depressive symptoms would be associated with lower SIF, this hypothesis is not supported by the data.

That no conclusive evidence of correlations was found in the TS condition superficially seems to be in line with the hypothesis. However, this prediction was based on the idea that being handed a clear strategy to avoid thinking about the No-Think targets would alleviate the need for cognitive control, which was theorized to be impaired in depressed individuals (Chen et al., 2022; Joorman et al., 2009). Therefore, the absence of evidence for correlations in the TA condition to compare them with renders these results uninformative on this subject.

Theoretical Implications

The finding of an SIF effect in the SP condition is added to a growing base of literature in which this effect is found, increasing its robustness. It seems indeed to be possible to actively push information out of consciousness and thereby forget it. What is less clear, however, is the mechanism through which this occurs.

Anderson and Green (2001) theorized that inhibition is a key process for SIF. They provided evidence to support this claim by showing an SIF effect using Independent Probes to test recall of the target words, which eliminates possibly interfering elements like the strength of the cue-target associations and instead measures the availability of the memory of the target word on its own. In the current study, no SIF effect (or control effect) was found in the IP condition. In tandem with other studies that did not find conclusive evidence regarding this subject (e.g., Wessel et al., 2020), this calls into question the validity of inhibition as a mechanism for SIF. If the target words do not themselves lose accessibility, what exactly does

the TNT task accomplish? It could be argued that suppression in this case only affects the strength of the association between cue and target (see also Anderson & Green, 2001). While in itself still an interesting phenomenon, it seems less clear how this would be generalizable to other contexts. It challenges the ecological validity of SIF based on a TNT task as a model for intentional forgetting of unwanted memories outside the laboratorium, for instance relating to past traumatic events. At least, it warrants a degree of caution in interpreting SIF findings.

The null findings regarding the relations between depressive symptoms and SIF provide another interesting inconsistency with existing literature (e.g., Joorman et al., 2009; Stramaccia et al., 2021). Provided that these results are valid, they seem to imply either that a higher score on depression-related measures is not accompanied by an impairment of the cognitive control necessary to successfully suppress, or that cognitive control is not as important for SIF as previously posited (Chen et al., 2022). At least at face value, based on the available literature on rumination and cognitive control, neither of these options seem very likely. However, the methodological considerations discussed in the next section might provide alternative explanations of these results.

Methodological Considerations and Limitations

A few factors have been identified that could have affected the current results and should be considered before drawing confident conclusions.

A first consideration concerns the sample, which consisted solely of first-year psychology students, who were predominantly female. Although other non-clinical studies often seem to have similar samples, it does not accurately represent the general population. This does not need to be an issue, but this group might inherently perform differently than other groups would. For instance, it might be assumed that general intelligence is relatively high in this group, which might affect performance on a task that requires memorizing a sizable list of word-pairs and engaging in a challenging task such as the TNT task. An

interesting observation that might in part be explained by the intelligence of the sample is that overall recall scores, across conditions, were very high, with multiple participants performing nearly faultlessly in the final tests. Thus, a ceiling effect seems to have emerged, making it more difficult to discriminate between the different conditions as data points are closer together than they might otherwise have been. In other studies (e.g. Anderson & Green, 2001), this effect does not seem to be as pronounced.

Interestingly, Wiechert et al (2023), who conducted a similar experiment in a more varied population, did not find evidence for SIF, although this might also be explained by the fact that it was conducted in an online format. Certainly, it seems prudent to refrain from confidently generalizing the findings to the general population.

Additionally, the sample was non-clinical, which means the scores on depression and repetitive thinking were generally very low. This might have greatly reduced the degree to which it was possible to discriminate between different scores. This is an important limitation of this study when it comes to testing the hypothesis regarding the association between SIF and depressive symptoms. Paired with the fact that correlations were computed separately for the TA and TS conditions, thereby reducing the sample size, it would have made it very difficult to find significant correlations. Thus, no strong conclusions should be drawn from these results.

Another factor that is relevant for the interpretation of the results concerns the questionnaires that were used to measure depressive symptoms, specifically the RTQ-10. Much of the literature surrounding SIF and depressive symptoms centers around rumination. As the current study was part of a larger research project, the available questionnaires were limited, and no pure rumination measure could be administered. The RTQ-10 measures repetitive thinking, which is a construct that is described to contain elements of both depressive rumination and anxiety-related worrying. Thus, some caution should be exercised

in using this questionnaire to make claims about rumination. However, theoretically, rumination, worry and repetitive thinking are very interlinked and similar constructs (McEvoy et al., 2014; Nolen-Hoeksema et al., 2008), and an additional analysis in the current study revealed that the scores on the PHQ-9 and the RTQ-10 were moderately correlated ($r = 0.44$). These factors increase the confidence that repetitive thinking is related to depression and can therefore yield meaningful results.

Future Research

Based on the results obtained in the current study, and taking into account its methodological limitations, a few areas of future research would be recommended. This should for instance focus on providing more evidence for the phenomenon of SIF, especially when it comes to designs using Independent Probes. More studies and reviews regarding this subject might provide more insight into the mechanism of SIF, and the degree to which evidence for it can be generalized to motivated forgetting as it is observed for instance in clinical practice. This is necessary in order to be able to use SIF evidence for describing and treating cases that deal for example with apparently repressed traumatic memories. To avoid the methodological problems and limitations present in this study, these projects should endeavor to use representative samples.

To further study depression and rumination as it relates to SIF, more research is warranted based on clinical and sub-clinical samples that show the diversity of symptom severity necessary for identifying patterns in the data. Validated measures should be used to operationalize these constructs.

Overall Conclusions

Overall, the findings of previous research on Suppression-Induced Forgetting were partially replicated. The effect was found in the condition using Same Probes, but not in the condition using Independent Probes. Regardless of methodological limitations relating to the

sample and the stimuli, these findings might have important theoretical implications by on one hand adding evidence for the existence of SIF, but on the other hand calling into question the theory underlying these findings.

Additional evidence was found for the claim that being instructed to use Thought Substitution during the TNT task is associated with a larger SIF effect than being instructed to strictly use Thought Avoidance, implying that having a clear strategy for suppression might be beneficial for motivated forgetting.

The results of the investigation of the relationship between depression and SIF are less insightful, as methodological challenges undermined the likelihood of obtaining significant correlations. Future research might provide more insight in this topic, and the mechanisms underlying possible correlations. This might come to play an important role in understanding the roles of cognitive control and intentional forgetting when it comes to depression, and subsequently the way this could be applied during treatment.

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Appendix A

Figure 1

*Boxplots showing the distributions of SIF and Control variables*
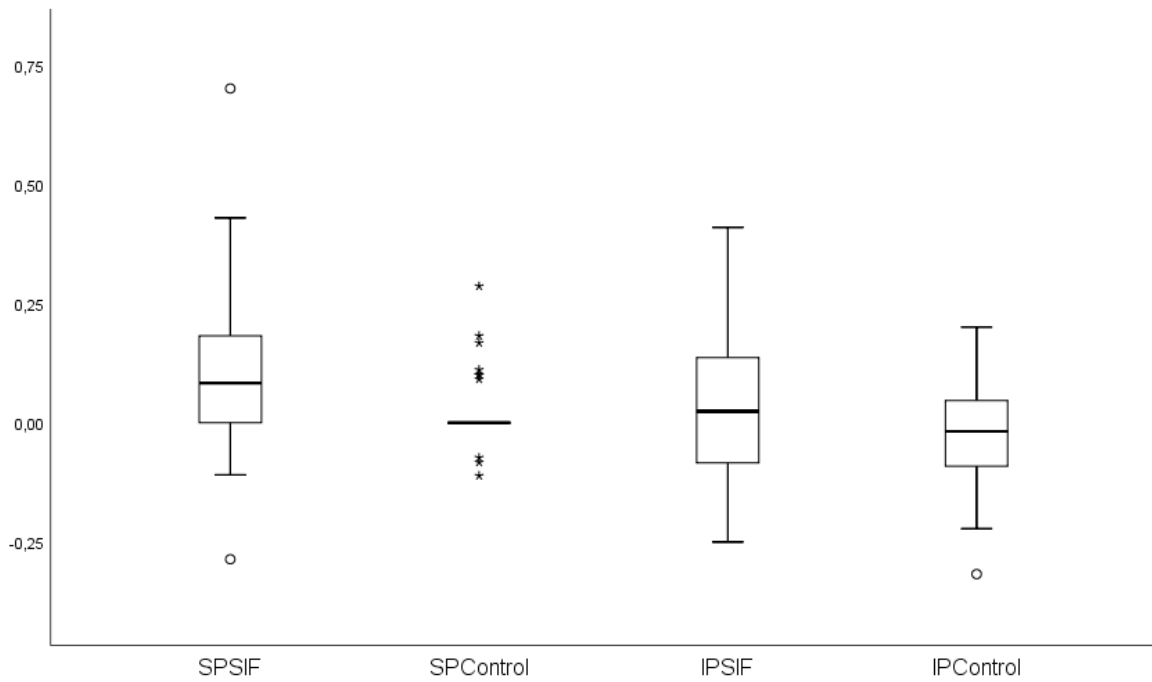
Note. Abbreviations: SPSIF = Suppression-Induced Forgetting in the Same Probe conditions, SPControl = Positive Control effect in the Same Probe condition, IPSIF = Suppression-Induced Forgetting in the Independent Probe Condition. IPControl = Positive Control effect in the Independent Probe condition.

Figure 2

Correlations Between Depressive Symptoms and SIF in the Thought Avoidance Condition
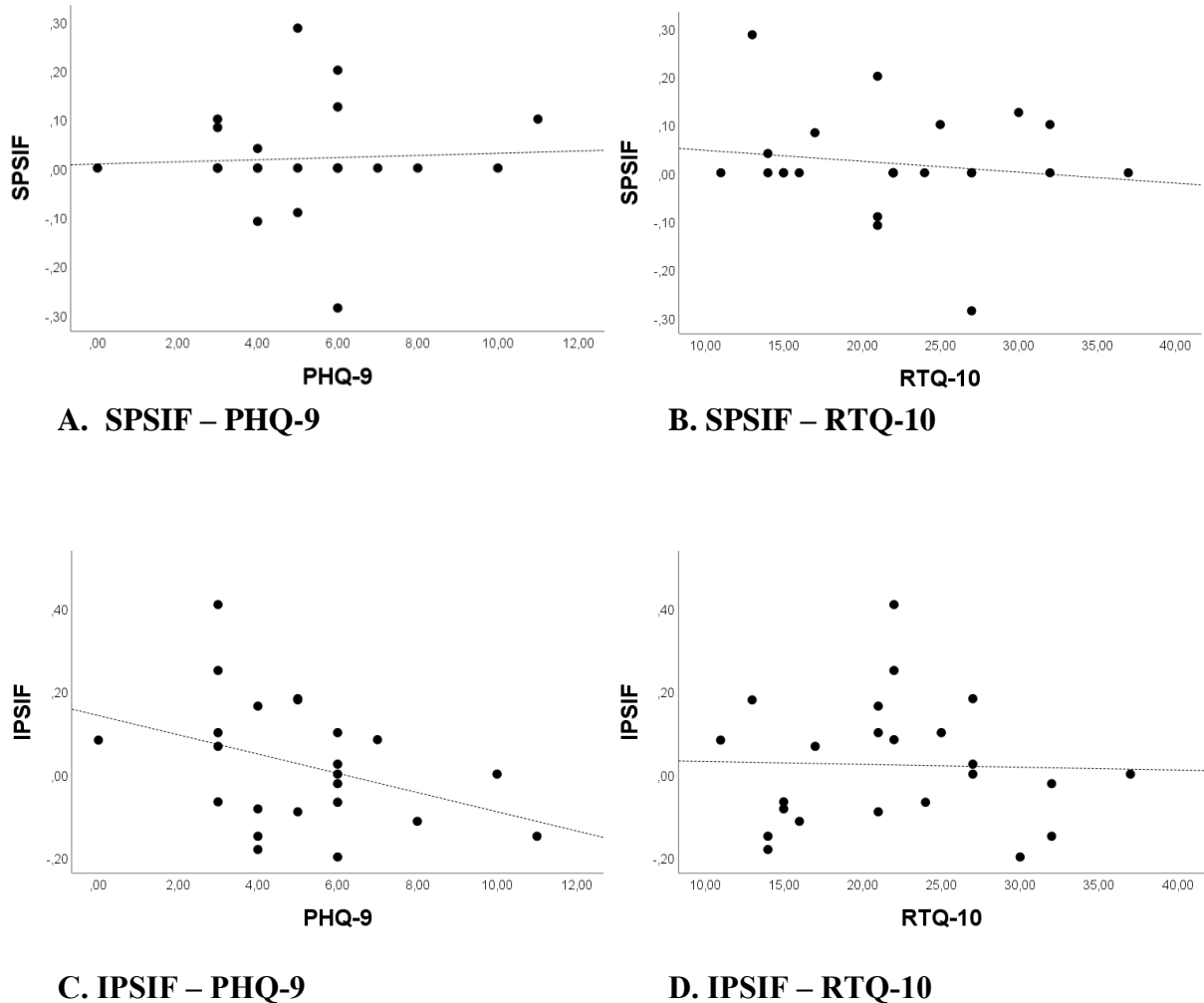
A. SPSIF – PHQ-9

B. SPSIF – RTQ-10
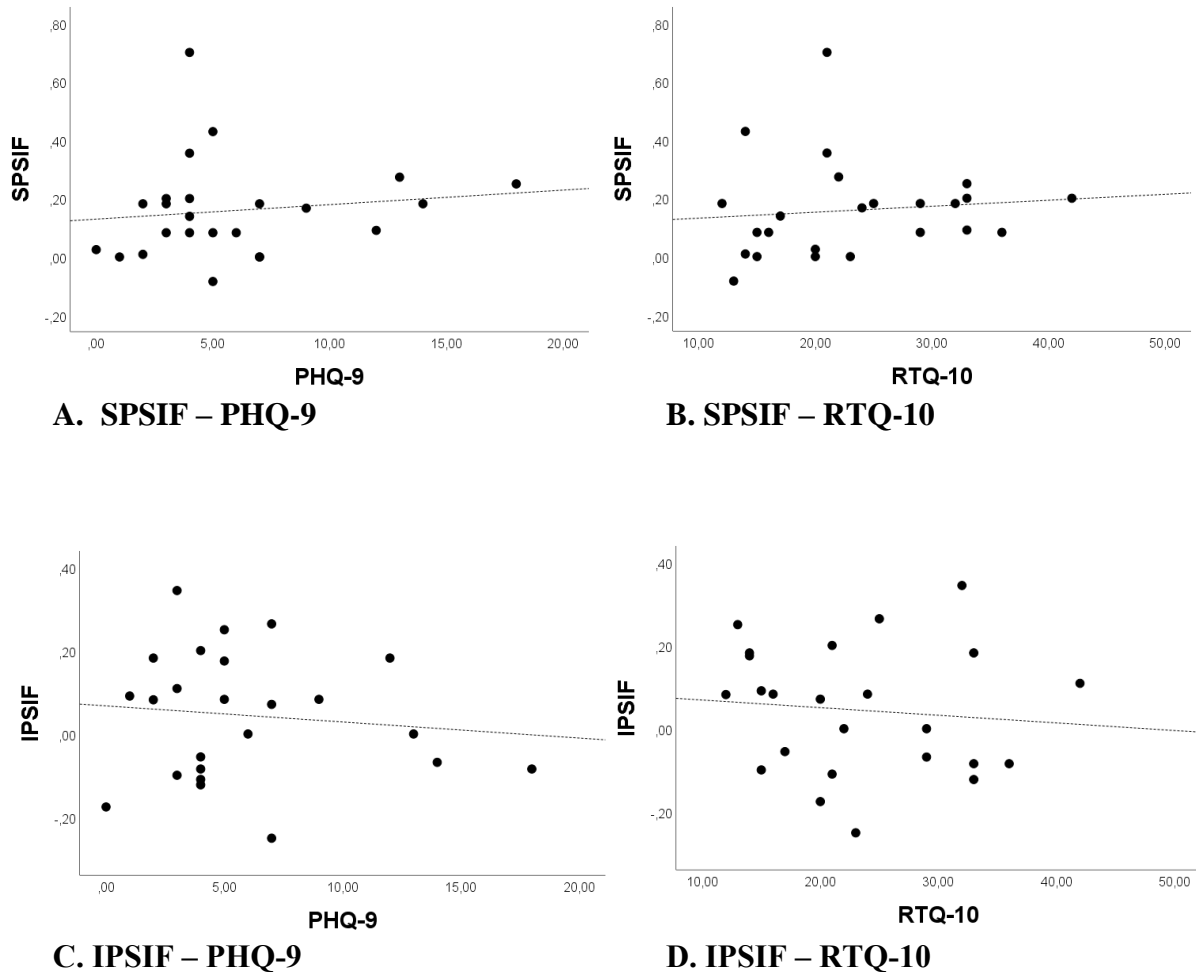
C. IPSIF – PHQ-9

D. IPSIF – RTQ-10

Note. Each scatterplot represents the relationship between a measure for depression or repetitive thinking (PHQ-9 or RTQ-10) and Suppression-Induced Forgetting (SPSIF or IPSIF) in the Thought Avoidance condition. None of the correlations were found to be statistically significant ($p > .05$). Abbreviations: SPSIF = Suppression-Induced Forgetting in the Same Probe condition, IPSIF = Suppression-induced Forgetting in the Independent Probe condition, PHQ-9 = 9-item Patient Health Questionnaire (Kroenke et al., 2001), RTQ-10 = 10-item Repetitive Thinking Questionnaire (McEvoy et al., 2014).

Figure 3

Correlations Between Depressive Symptoms and SIF in the Thought Substitution Condition

A. SPSIF – PHQ-9

B. SPSIF – RTQ-10

C. IPSIF – PHQ-9

D. IPSIF – RTQ-10

Note. Each scatterplot represents the relationship between a measure for depression or repetitive thinking (PHQ-9 or RTQ-10) and Suppression-Induced Forgetting (SPSIF or IPSIF) in the Thought Substitution condition. None of the correlations were found to be statistically significant ($p > .05$). Abbreviations: SPSIF = Suppression-Induced Forgetting in the Same Probe condition, IPSIF = Suppression-induced Forgetting in the Independent Probe condition, PHQ-9 = 9-item Patient Health Questionnaire (Kroenke et al., 2001), RTQ-10 = 10-item Repetitive Thinking Questionnaire (McEvoy et al., 2014).