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To Suppress, To Remember or To Forget Intrusive Memories

Tess van den Dungen

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University of Groningen

Examiner/Daily supervisor: Dr. Ineke Wessel

Second Supervisor: Renee Kleine Deters

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Abstract

This study is a replication of Wessel et al. (2023) about the Suppression Induced Forgetting Effect (SIF). The SIF effect suggests that actively suppressing memories, impairs later recall. With the Think/No-Think task we examined this. Participants learned cue-target word pairs and were asked to either think about (Think targets, presented in green) or to avoid thinking about the target (No-Think targets, presented in red). The SIF effect means that No-Think targets are recalled worse than baseline targets. Wessel et al. (2023) found the SIF effect in an in-lab setting, but they replicated Wiechert et al. (2023) who did not find the SIF effect in an online setting. This current study examined both settings, with the expectations of finding the SIF effect. Furthermore, this study examined the relationship between the SIF effect and intrusive memories, this relationship has been found in previous research and therefore it was expected that people who are better at suppressing memories report less intrusive memories. The participants were $N = 90$ first-year psychology students. The results showed a significant SIF effect in the in-lab setting, but not in the online setting. A positive control effect found within both settings, which means that the Think targets were recalled significantly better than baseline targets. No significant correlation was found between SIF and intrusive memories. These results could suggest that the SIF effect could be harder to find with an online setting, and that the relationship between SIF and intrusive memories could be difficult to find in certain samples.

Keywords: Suppression-Induced Forgetting, SIF, Think No-Think Task, Intrusive Memories

To Suppress, To Remember or To Forget Intrusive Memories

When people become a victim of a crime, they can get traumatized. Some of them get intrusive memories of the event. These intrusive memories are defined in the DSM-5 as a possible symptom of Post-Traumatic Stress Disorder and are explained as recurrent, involuntary, and intrusive distressing memories of a traumatizing event (American Psychiatric Association, 2013). What if, when people actively try to not think about those intrusive memories, they could forget them? There is a concept known as Suppression Induced Forgetting (SIF), suggesting that suppressing memories impairs the later recall of those memories (Wiechert et al, 2023). Wessel at al. (2023) looked at this SIF effect and this current study tried to replicate that.

Suppression Induced Forgetting

Not all memories are happy memories, some memories we would like to forget. Hu et al. (2017) mention the commonly held belief that forgetting is not desired, but there are certain memories that some people would rather not recall. Therefore, it is understandable that people avoid things that remind them of those undesired memories. However, reminders of those memories can sometimes be inevitable to avoid. Those reminders can be people, places, or objects that trigger the unwelcome retrieval of those unwanted memories. When people get confronted with those unwanted memories, they often try to suppress the retrieval of those memories, which can affect their accessibility later (Hu et al., 2017).

Anderson and Green (2001) stated that when people get unwanted memories and they try to suppress it, it becomes more difficult for them to recall the memory later. The more frequently the memory was avoided, the more about the memory was forgotten. Anderson and Green (2001) believed that forgetting parts of those memories was caused by suppressing the memory. That is the so-called SIF effect. To give a clearer definition, Wiechert et al. (2023) explained it as follows: the SIF effect suggests that actively suppressing memories, preventing them from entering awareness, impairs later recall of those memories.

To study the SIF effect, there was a method developed called the Think/No-Think paradigm by Anderson and Green (2001). During this procedure participants needed to learn word pairs, after which they were instructed to either think (Think targets) or not to think (No-Think targets) about some of those word pairs. The Baseline targets were learned in the beginning but were not used during the Think No-Think phase. The idea is that they would recall less of the word pairs of which they were instructed not to think about, the ones they suppressed.

Wiechert et al. (2023) tested participants through an online session and did not find a significant SIF effect. Wessel et al. (2023) tested participants in an in-lab setting and did find the SIF effect. Stramaccia et al. (2020) examined the SIF effect with their meta-analysis, by using multiple studies that examined the SIF effect and looked at all those findings together to get a more general overview of the SIF effect. They found that in healthy individuals, avoiding retrieval of the memory led to significantly forgetting those memories. They also found that a greater SIF effect was shown when the individual had a stronger repressive coping style. People with a repressive coping style are described as using an avoidant style of information processing, they try to avoid negative affect (Myers, 2010). However, Stramaccia et al. (2020) was a selective meta-analysis and therefore there are no hard conclusions that can be made from it, but it helps with getting an idea about the SIF effect and its relationships.

SIF and Intrusive Memories

If someone is better at suppressing memories, will they have less intrusive memories? Particularly Posttraumatic Stress Disorder is characterized by intrusive memories and thoughts (American Psychiatric Association, 2013). After their trauma, the intrusive memories that people with PTSD deal with, may be the result of an impaired ability to avoid these unwanted memories. Catarino et al. (2015) mention that memories of the past can serve as adaptive, but emotional wellbeing can be affected by intrusive memories of negative events. People who have PTSD are particularly affected by this. The intrusive memories of their trauma are causing impairment in their everyday functioning. In connection with the SIF effect, it has been found that people with large deficits in SIF, experienced the most severe PTSD symptoms (Catarino et al., 2015).

There are also other disorders where intrusive memories or thoughts play a part, for example anxiety and depression (Stramaccia et al. 2020). Stramaccia et al. (2020) also compared the SIF effect found between healthy individuals and anxious and depressed individuals. They found that the SIF effect was larger in healthy individuals, than for individuals who are more anxious or depressed. They therefore suggest that psychological wellbeing is characterized by intact suppression induced forgetting, and therefore propose that suppression of memories can serve as a mechanism to help with controlling the retrieval unwanted memories.

According to Stramaccia et al (2020) the core of several psychological disorders may be a deficiency in controlling memories and thoughts. Chen et al. (2022) discuss that some people can easily manage their intrusive memories, whereas other people have more difficulty with that. They mention that it is considered a critical ability for mental health when people

can suppress the retrieval of unwanted memories. They also mention that not all individuals are effective at suppressing those memories and suggest that the core of some psychological disorders is a deficit in controlling the retrieval of memories. Chen et al. (2022) explain cognitive control as being flexible in distributing mental resources to prioritize current goals. They found that a higher capacity of cognitive control (CCC) showed a larger reduction in intrusive thoughts and higher SIF. They also found that during the TNT task people with higher CCC were more successful in controlling memory awareness. They name CCC as one of the important factors that determine is people can control their intrusive memory and therefore affects the SIF effect. So, intrusive memories and being able to suppress and control them seems to have an influence SIF. Therefore, this study will also try to find a connection between intrusive memories and SIF.

The Current Study

The current study examined to what extend the SIF effect can be replicated. This is a replication of Wessel et al. (2023), which on itself was a replication of Wiechert et al. (2023). Since the results of Wessel et al. (2023) and Wiechert et al. (2023) don't agree with each other, one finding the SIF effect in the in-lab setting and the other not finding it in the online setting, this study tested participants in both the online and in-lab settings to try and find the SIF effect in both. This has been examined using a sample of first-year psychology students who did the Think/No-Think task. The expectation, for the online and in-lab, was that the participants would recall fewer No-Think targets than Baseline target (SIF effect) and to recall more Think targets than Baseline targets (Positive control effect). Furthermore, this study examined if there is a relationship between the SIF effect and intrusive memories. This has been examined with the Think/No-Think task for the SIF effect and the Impact of Event Scale Revised (Weiss & Marmar, 1997) was used to measure intrusive memories. The expectation was that people who were better at suppressing memories would report less intrusive memories. If people who are better at suppressing memories report less intrusive memories, it can be helpful to train people who suffer from intrusive memories to get better at suppression, so they would maybe suffer less from those intrusive memories.

Method

Design and Power Analysis

Since this is a replication study, the same design and power analysis from Wessel et al. (2023) were used. The design was a one-factor within-participant design with 3 levels of instruction condition: Think, No-Think and Baseline. Wessel et al. (2023) did an a priori sample size calculation accounting for making crucial comparisons. Their one-sided $\alpha = .025$ power analysis revealed that 54 participants would be required to detect a medium effect size (Cohen's $d = .5$) with a power of .95. Since they only had one setting, the in-lab setting, and we had two settings, online and in-lab, the required number of participants was 54 in both settings. Therefore, a total of 108 participants was required.

Transparency statement

This experiment was approved by the Ethics Committee of the department of Psychology of the University of Groningen (Research code PSY-2324-S-0182).

The hypotheses, method, and data analysis plan were preregistered on the Open Science Framework (https://osf.io/s73mf). Apart from that, for the purpose of this master thesis project, there was an extra administered self-reported measure for intrusive memories. Furthermore, there were also more extra administered self-reported measures, meant for other master thesis project, and those were not used for this specific project.

There were two deviations from the pre-registration. Firstly, the question about a mental disorder a participant had in the past was not used as an exclusion criterion anymore, if the person did not have the mental disorder diagnosis currently and did not experience any problems because of that. Secondly, the number of participants that was calculated with the power analysis was not achieved, this was due to lack of time because of the deadline that was approaching for this master thesis project.

Participants

There were 90 eligible participants for this experiment. There were 41 participants in the online setting, and 49 in the in-lab setting. The participants were first-year students of the bachelor Psychology at the University of Groningen, who participated in exchange for course credit. The participants came from both the English- and the Dutch language Psychology Bachelor programs, of which admittance criteria include fluency in the English language. In table 1 a summary is shown of the demographics of the total sample, and for the online and the in-lab settings separate.

Table 1

Demographics of the Sample

		Total	In Lab	Online
	Participants (N)	90	49	41
Gender	Female	63	33	30
	Male	24	15	9
	Prefer not to say	2	1	1
Age	Mean	20	21	20
	Range	18 - 36	18 - 36	18 - 32
Native Language	English	12	6	6
	Dutch	26	14	12
	German	17	11	6
	Other	34	18	16

The inclusion criteria used, were the same as Wiechert et al. (2023) and Wessel et al. (2023): age should be between 18 and 45; the answers “no” to: “Do you have normal or corrected-to-normal eyesight?”, “Do you have dyslexia?”, “Are you colorblind?”, and “Do you have a diagnosed, on-going mental health/illness/condition?”. The question about a mental disorder they had in the past was not used as an exclusion criterion anymore, if the person did not have the mental disorder diagnosis currently and did not experience any problems because of that. The test feedback phase of the TNT should be under 25 minutes, otherwise the participant needed to be excluded as well. Furthermore, in the end questionnaire there were some questions used to control for if the participant did the task correctly, these were the Compliance questionnaire and Session Environment questionnaire (see materials). If they scored too high, it meant that they did not understand and do the assignment correctly and therefore needed to be excluded.

Initially there were 105 participants in total, but after exclusions 90 participants remained eligible. The amount and reasons for the exclusions in the online and in-lab setting are shown in table 2.

Table 2

Reasons for exclusions

	Online	In-lab
Current mental disorder	1	3
Compliance Questionnaire score > 4	4	1
Exceeded 25-minute time-limit	2	1
Data problem	1	0
Participant computer problems	2	0

Materials

Since this is a replication, most of the material is adopted from Wessel et al. 2023, and exploratory measures were added. The TNT task and the diagnostics questionnaires were done within Inquisit lab version 6.6.1 (Millisecond software, 2022). The rest of the questionnaires were designed within and answered through Qualtrics (https://www.qualtrics.com, 2024).

Think No-Think Task

The same code as Wessel et al. (2023) was used for the TNT task. The tasks consist of 54 cue-target word pairs (e.g. BOND-WEDDING). The word pairs were divided into three groups of 12 pairs and 18 filler pairs. There were 3 versions of the task (A, B, and C), where the three groups of 12 pairs were counterbalanced across the Think, No Think and Baseline conditions.

TNT Task Phases

The TNT task consists of six phases. These phases are explained briefly, for specifics see Wessel et al (2023) and Wiechert er al. (2023). The first phase is the learning phase, where all the cue-target word pairs were presented on the screen and the participants were told to study them.

During the Test-Feedback phase participants needed to recall the word pairs that they studied. The cue words appeared on the screen one by one, and the participant needed to respond with the right response word out loud. If they failed to remember, it appeared on the screen so they could study it again. This continued until the participant had each word pair correct once. This phase had a 25-minute time-limit.

The Practice Think No-Think phase starts with the instructions for the TNT task. Think words appeared on the screen in green and participants were instructed to recall the

associated word out loud. No-Think words appeared on the screen in red and participants were instructed to not think about the associated word. The experimenter emphasized that for the red words the participants should suppress the retrieval of the associated word and do that by focusing on the red word on the screen, and not by alternative thoughts (Wessel et al., 2023; Benoit & Anderson, 2012). If the participant did not respond to the green words, they saw the associated word in blue. If the participant responded to red words, they saw an error message on the screen, reminding them of the task. This phase consisted of 12 filler pairs that were presented in 48 trials. After this, the diagnostic questionnaire appeared on the screen. The experimenter and participant filled the questionnaire in together and if necessary, the experimenter repeated some of the instructions.

The real Think No-Think phase had the same instructions as the practice phase. There were 12 Think words and 12 No-Think words, each word was presented 12 times. During this phase the participant got two one-minute breaks. The diagnostic questionnaire was also presented again during this phase, about halfway through, to check whether the participant understood the assignment and if necessary, the experimenter repeated some of the instructions.

During the Same-Probe (SP) test all the words from the learning phase were presented again. The Baseline words were learned in the beginning but were not used during the Think No-Think phase. The Think, No-Think and Baseline words appeared on the screen in a random order and the participant needed to respond to all the words.

Diagnostics Questionnaire (Anderson et al., 2004)

With this 7-item questionnaire it was assessed whether the participant understood and followed the instructions of the experimental procedure. An example item: “When the red hint word went off the screen, how often did you then think of the word that went with it?”. The answers on this scale ranged from 0 (Never) to 4 (always), only with the last question the answer was in number of seconds: “typically for how many seconds did you look at the red hint word when it was presented on the screen.” (0s to 4s, answer should be 4s). The participants filled in this questionnaire together with the experimenter. The experimenter read the questions out loud and gave feedback on the answers if they thought the participant did not understand the assignment correctly.

Comliance Questionnaire (Levy & Anderson, 2012)

This questionnaire consisted of 3 questions with a 5-point answer scale, 0 (Never) to 4 (Always), and was used to determine whether the participant followed the instructions they were given. This questionnaire was used as an exclusion criterion, participants were excluded

when their total score was higher than 4. The three items were: “When I saw the RED HINT word, I quickly checked to see if I remembered the response word”, “After a RED HINT word went off the screen, I checked to see if I still remembered the response word.”, and “ When I saw a RED HINT word, I thought about the response word that went with it in effort to improve my memory of that word pair.”.

Session Evaluation Questionnaire (Zwaan et al., 2018)

This questionnaire consisted of ten questions with 3-point Likert scales, 1 (none at all), to 3 (very much). This questionnaire was also used for the exclusion criteria. There were two distraction questions (“there are a lot of distractions here” and “I was distracted during the experiment”), when for either of those questions the answer “very much” was selected, the participant needed to be excluded. Those two items had an internal reliability of Cronbach’s Alpha = .48

Exploratory measures

The Impact of Event Scale-Revised (Weiss & Marmar, 1997)

This scale consists of 22 items, scored from 0 (not at all) to 4 (extremely) and are divided into the subscales: Intrusion, Avoidance and Hyperarousal. Since this research looked at intrusive memories, the subscale Intrusion will be most important. Item examples of this subscale are: “I thought about it when I did not mean to.” and “Other thinks kept making me think about it”. The internal reliability of this scale within this experiment was Cronbach’s Alpha = .94. Looking only at the intrusion subscale the internal reliability was Cronbach’s Alpha = .89. For the instructions and all items of this questionnaire, see Appendix A.

Procedure

The experiment was carried out in English. The testing sessions were conducted by four students in the MSc. Programme Clinical Forensic Psychology and Victimology, and one student in the BSc. Psychology Honours Programme. All the experimenters had to pass an English language proficiency test on a C1 & C2 level (they had to score above 80% on the Lextale Test, Lemhöfer & Boersma, 2012). The experimenters needed to know the word pairs of the TNT task with 100% accuracy and were tested on them. Furthermore, all the experimenters needed training to be able to conduct the experiment. The training was given by two experimenters, the lead author of Wiechert et al. (2023) and a co-author of Wessel et al. (2023). The training took multiple sessions and in the end the experimenters needed to pass a final mock trial evaluation session. During the experiment, when at about half of the participants tested, one of the lab trainers evaluated the adequacy of the experimenters again.

The participants signed up through a participant recruitment system called SONA. In the advertisement the study was mentioned to be relating to avoiding distractions, explicitly not mentioning anything about memory. Since this experiment had two different study settings, online and in lab, there were two different advertisements, and participants were randomly assigned to seeing either only the online or only the in-person advertisement. This was done through the recruitment system, where they divided all possible participants into five groups using the last two digits of their phone numbers, and by asking chatgpt to randomly assign these groups to the online or the in-lab advertisement. For the online setting, participants were individually tested via Google Meet. For the in-person setting, the participants were tested individually in a laboratory room. The laboratory room consisted of a larger room, where the experimenter was during the experiment, and a smaller room attached to that where the participant was. The door in between the two rooms remained open during the experiment. Every experimenter had the same script and read every instruction out loud, so every participant got the same instructions. The experiment started with the participant reading the research letter, this contained information about the study, what they could expect and what was expected of them during the experiment. If they agreed to participate, they signed the informed consent. After this, the inclusion criteria were checked. When the participant was found eligible, the instructions for the TNT task were given. When starting with the TNT task, for the online setting the experimenter shared their screen, and for the in-person setting the computer screens of the experimenter and participant were connected so they saw the same screen. The participant needed to say their answers out loud, while the experimenter was listening and coding their responses. By asking Chat.gpt to give random orders of the letters A, B and C, the participants of every experimenter were randomly assigned to either the A, B or C conditions. They were assigned in blocks of three, so that every block had one A, one B and one C. The experimenter opened the right condition for the participant, and the TNT phases were completed

In the last phase the participant needed to complete some questionnaires. These questionnaires were the compliance screening, the Session Evaluation Questionnaire, and some exploratory measures (for this thesis, the Impact of Event Scale-Revised, see materials). During this phase, the experimenter turned off their own screen, to give the participant some privacy. For the online setting, the experimenter stopped sharing their screen. After finishing the questionnaires, the participant was thanked for their participation, and they received their compensation. They were informed that they would get a full debriefing at the end of the data

collection, to avoid influencing other participants during the experiment, and that this would be no later than 15th of April 2024.

Data Analysis Plan

The first step was to remove the participants that needed to be excluded and then the descriptive statistics of the sample were examined. After this we anonymized the data, by removing any possible identifiers and assigning the participant random numbers.

The first hypothesis was that the participants would recall fewer No-Think targets than Baseline target, in both the online and in-lab settings. First, the dataset was separated into two groups: online and in-lab. Then the assumptions for a one-tailed paired sample t test were examined, with the difference variable that was calculated by the score on the baseline items minus the score of the suppression items. When the assumptions were met the tests were executed in SPSS to examine whether there was a difference in recall of the words from the No-Think targets and the words from the Baseline targets in the online as well as the in-lab setting.

The second hypothesis was that the participants would recall more Think targets than Baseline targets, in both the online and in-lab settings. First, the dataset was separated into two groups: online and in-lab. Then the assumptions for a one-tailed paired sample t test were examined, with the difference variable that was calculated by the score on the recall items minus the score of the baseline items. When the assumptions were met the tests were executed in SPSS to examine whether there was a difference in recall of the words from the Think targets and the words from the Baseline targets in the online as well as the in-lab setting.

The third hypothesis was that people who were better at suppressing memories would report less intrusive memories. The assumptions for Pearson's Correlation were examined. When the assumptions were met the test was executed in SPSS to examine if there was a relationship between suppression of memory and intrusive memories. The SIF score was calculated by the score on the baseline items minus the score on the suppression items. This test was executed twice, once to examine the relationship of the entire IES-R score with the SIF score and once to examine the relationship of only the intrusion items of the IES-R with the SIF score.

For all hypotheses the extreme outliers that were found were removed from the analysis. Extreme outliers were defined as difference scores that were smaller than the first quartile by three times the interquartile range and larger than the third quartile by three times the interquartile range.

Results

Suppression Induced Forgetting Effect

In the in-lab setting ($N = 49$) there were no extreme outliers found (See Appendix C) and the assumptions of the one-tailed sample t-test were met (See Appendix B Figure 3). The results for the in-lab setting showed that the recall of the No-Think targets ($M = .804$, $SD = .149$) was significantly lower than the recall of the Baseline targets ($M = .862$, $SD = .106$; t (49) = 3.174, 95% CI [.021; .094], p = .001, one-tailed; Cohen's $d = .453$). This analysis revealed that the suppression induced forgetting effect was statistically significant in this setting, which means that the number of words participants recalled of the No-Think targets was better than that of the Baseline targets.

In the online setting ($N = 41$) the assumptions of the one-tailed paired sample t-test were met (See Appendix B Figure 4), and there were no extreme outliers found (See Appendix c). The results for the online setting showed that the recall of the No-Think targets ($M = .803$, $SD = .175$) was not significantly different from the recall of the Baseline targets ($M = .829$, $SD = .152$; t (41) = .772, 95% CI [-.043; .096], $p = .222$, one-tailed; Cohen's $d = .121$). This analysis revealed that the Suppression Induced Forgetting effect was not statistically significant in this setting, which suggest that there was no real evidence found for a difference between the number of words the participants recalled of the No-Think targets and the words they recalled of Baseline targets.

Table 3

TNT Task Score Overview

		SIF Effect		Positive Control Effect	
		In-lab	Online	In-lab	online
Mean	No-Think Targets	.804	.803	-	-
	Baseline Targets	.862	.829	.868	.829
	Think Targets	-	-	.990	.982
Mean Difference	Baseline - No-Think	.057*	-.026	-	-
	Think - Baseline	-	-	.122*	.152*

Note. * $p < .05$

Positive Control Effect

In the in-lab setting there was one extreme outlier found (See Appendix C) and the assumptions of the one-tailed sample t-test were met (See Appendix B Figure 5). The results

for the in-lab setting showed the recall of the Think targets (M = .990, SD = .028) was significantly higher than the recall of the Baseline targets (M = .868, SD = .099; t (48) = 8.405, 95% CI [.092; .151], p < .001, one-tailed; Cohen's d = 1.213). This analysis also revealed a significant positive control effect, which means that the participants recalled more words for the Think targets than for the Baseline targets.

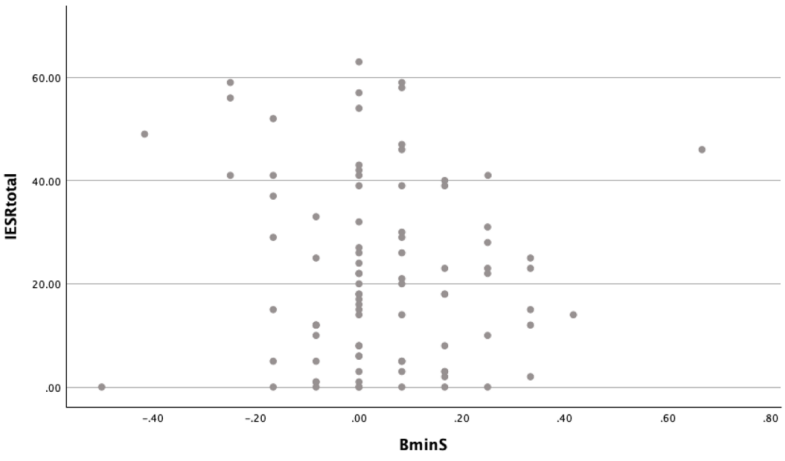
In the online setting there were no extreme outliers found (See Appendix C) and the assumptions of the one-tailed sample t-test were met (See Appendix B figure 6 and 7). The results for the online setting showed that the recall of the Think targets (M = .982, SD = .051) was significantly higher than the recall of the Baseline targets (M = .829, SD = .152; t (41) = 6.453, 95% CI [.105; .200], p < .001, one-tailed; Cohen's d = 1.008). This analysis revealed a significant positive control effect, which means that participants recalled more words for the Think targets than the words they recalled for the Baseline targets.

Relationship Between the Suppression of Memories and Intrusive Memories

For this hypothesis there was no separation between the online and in-lab setting. There were 89 participants in total who filled in the IES-R questionnaire, the mean was 22.30 with a standard deviation of 17.728. The distribution of the difference score between baseline and suppression items in the total sample was normally distributed (See Appendix B Figure 8) The results of the IES-R questionnaire were not normally distributed and that therefore the assumptions of the Pearson's correlation were violated (see Appendix B Figure 9), no extreme outliers were found (See Appendix C). Therefore, the relationship between suppression of memories and intrusive memories was examined through the Spearman's rho Correlation.

Figure 1

Scatterplot of the relationship between SIF and IES-R



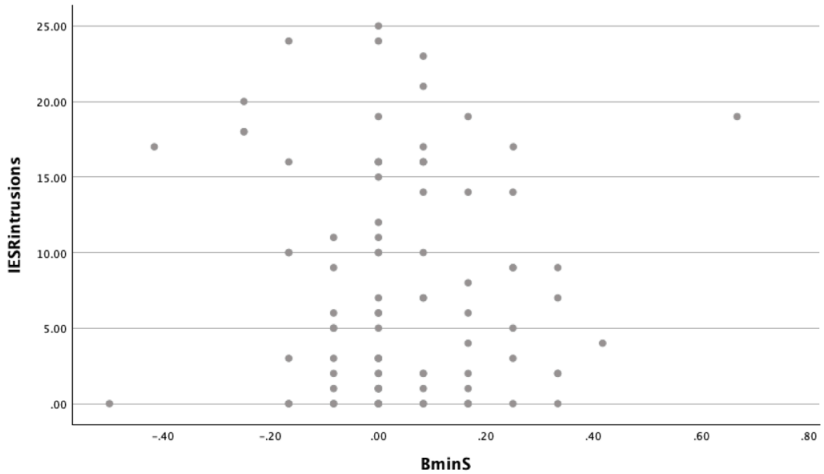
Note. This scatterplot depicts the relationship between SIF and IES-R and reveals a random scattering of the data points, no pattern or trend is shown.

The results showed that the Spearman's rho correlation coefficient (-.029) was not significant (p = .791). The scatterplot shown in figure 1 also shows no pattern or trend for this relationship. This means that there was no strong evidence that suggests that changes in the suppression of memory are associated with changes in intrusive memories. This indicates that participants who were better at suppressing memories did not necessarily experience less intrusive memories.

When looking at only the IES-R intrusion scale, the mean was 7.85 with a standard deviation of 7.31. There were no extreme outliers found (See Appendix C), and the assumptions of Pearson's correlation were violated (see Appendix B Figure 10). The Spearman's rho correlation was therefore used to examine the relation between suppression of memories and a more focused scale of intrusive memories. The results showed that the Spearman's rho correlation coefficient (-.041) was not significant (p = .703). The scatterplot shown in figure 2 also shows no pattern or trend for this relationship. The analysis therefore revealed that there is no strong evidence that suggests that changes in the suppression of memory are associated with changes in intrusive memories. This indicates that participants who were better at suppressing memories did not necessarily experience less intrusive memories.

Figure 2

Scatterplot of the Relationship Between SIF and IES-R Intrusion Items



Note. This scatterplot depicts the relationship between SIF and IES-R intrusion items and reveals a random scattering of the data points, no pattern or trend is shown.

Discussion

Findings of This Study

Partially in line with our hypothesis, the results revealed that the suppression induced forgetting effect was statistically significant in the in-lab setting, which means that it was that the number of words participants recalled of the No-Think targets was better than that of the Baseline targets. For the online setting, there was no significant difference found between the recall of the No-Think targets and the recall of the Baseline targets. This study was a replication of Wessel et al. (2023), where they only looked at the in-lab setting, and our findings are in line with theirs with finding a significant difference between the recall of the No-Think targets and the Baseline targets. The online setting was replicated from Wiechert et al. (2023) and our findings also align with theirs, where they did not find a significant difference between the recall of the No-Think targets and the Baseline targets. This could suggest that the SIF effect could be harder to find with an online setting.

In line with our hypothesis, the results showed a significant positive control effect, which means that it was measured that the participants recalled more words for the Think targets than the words they recalled for the Baseline targets. This was measured in both the online and in-lab settings. These findings are also in line with the findings of the study that was replicated, Wessel et al. (2023), and the findings of the study of Wiechert et al. (2023). For the positive control effect, it seems that setting does not specifically matter to find the effect, as for the SIF effect it seems that it does.

The results for the relation between suppression of memories and intrusive memories were not in line with the hypothesis. There was no significant correlation found between suppression induced forgetting and intrusive memories. These findings indicate that there is no strong evidence in this study that suggests that changes in the suppression of memory are associated with changes in intrusive memories. So, in this study, participants who were better at suppressing memories did not necessarily experience less intrusive memories. These results are not in line with previous research, where they did find a relationship between suppression of memories and intrusive memories. For example, Catarino et al (2015) found a connection between SIF and PTSD, including symptoms like intrusive memories. Furthermore Chen et al. (2022) found a connection between a larger reduction in intrusive memories and higher SIF, in connection with better cognitive control. However, in this study there was no comparison possible between healthy participants or participants with a mental disorder, which was the case for Catarino et al. (2015). This could suggest the relationship between SIF and intrusive memories is easier found within a sample of participants with a mental disorder,

since they already suffer from intrusive memories and the connection can be found clearer. With healthy participants, who do not suffer from intrusive memories, it could be harder to find a connection since there are no intrusive memories present. Comparing with the results of Chen et al. (2022), it could also be suggested that the connection between SIF and intrusive memories is easier found when another variable is added, like cognitive control capacity, that could help show the relationship clearer.

Limitations

One important limitation of this study was the sample that was used. The sample consisted specifically of first-year psychology students and therefore are not an accurate depiction of the general population, which could mean that there are different results in the general population. But since this was a replication of Wessel et al. (2023), the same kind of sample was used. Furthermore, the first-year psychology students were participating in exchange for course credit and had to do that for other experiments as well, and so their participation was motivated by the reward. Additionally, they are learning about psychological research and are encouraged to use critical thinking as much as possible, so it cannot be ruled out that some participants may had an idea about what we were trying to study. This could have led to them giving the desired answers during the TNT, meanwhile they kept studying the red words thinking they may need to recall them later. This could be for both the online and in-lab settings, but maybe more for the online, since there is a certain distance there, which is not the case in the in-lab.

It is important to mention however, that former research of the relationship between SIF effect and intrusive memories was done with participants who were diagnosed with mental disorders that caused them to have intrusive thoughts and therefore really suffered from it (Stramaccia et al., 2020; Catarino et al., 2015). This study did not have participants that were diagnosed with mental disorders, participants with a mental disorder were excluded in this study, and there was no mention of if they even had intrusive memories or thoughts at all, unlike the other studies. So therefore, it could be difficult to find a relationship between two variables, meanwhile one of the variables is not necessarily present in the sample. These results in comparison with previous studies could suggest that the relationship between SIF and intrusive memories could be more difficult to find in certain samples.

Implications Future Research

Since this study also did not find the SIF effect in the online setting, just like Wiechert et al. (2023), maybe future research could focus on that and why that is. Wiechert et al (2023) were the first to try and find the SIF effect through online meetings and there did not find the

effect. Therefore, in this study there was also a group who did an online setting, and the SIF effect was also not found. So maybe the explanation for that, could be that the SIF effect is more difficult to find through online sessions. A possible explanation could be that the participant is not paying as much attention as they would in the lab. Because in the lab the experimenter is sitting right behind the participants and they probably feel watched, and that feeling is less when they are seen through the webcam. They could be doing other things on their computer without the experimenter noticing. They are in a familiar environment which could be distracting as well, for example getting distracted by the things they see in their room.

To really investigate the connection between the SIF effect and intrusive memories, future research could use a sample where there a people represented that suffer from intrusive memories. They could then compare them to a control group, who do not have intrusive memories. Then it can be really compared if people who suffer from intrusive memories are better or worse at suppression induced forgetting compared to people without intrusive memories. PTSD is not the only mental disorder where people suffer from intrusive thoughts, so there could also be more research done looking into the relationship of suppressing memories and intrusive thoughts with people who have depression or anxiety.

Another idea for future research is to examine whether training in cognitive control can help people with controlling their memories and therefore maybe not suffer as much from the intrusive memories. Specifically training for people who already have problems with cognitive control and who suffer from intrusive thoughts, to see if they can get better at suppression induced forgetting after cognitive control training.

Conclusion

The conclusion of the current study, with a sample of first-year psychology students, is that a significant SIF effect was found in the in-lab setting, and there was not a significant SIF effect found in the online setting. The positive control effect was found within both settings, online and in-lab. Lastly, there was no significant relationship found between the suppression of memories and intrusive memories.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC

Anderson, M. C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature*, *410*(6826), 366-369. https://doi.org/10.1038/35066572

Anderson, M. C., Ochsner, K. N., Kuhl, B., Cooper, J., Robertson, E., Gabrieli, S. W., Glover, G. H., & Gabrieli, J. D. E. (2004). Neural Systems Underlying the Suppression of Unwanted Memories. *Science*, *303*(5655), 232-235. https://doi.org/10.1126/science.1089504

Benoit, R. G., & Anderson, M. C. (2012). Opposing mechanisms support the voluntary forgetting of unwanted memories. *Neuron, 76*(2), 450-460. https://doi.org/10.1016/j.neuron.2012.07.025

Catarino, A., Küpper, C. S., Werner-Seidler, A., Dalgleish, T., & Anderson, M. C. (2015). Failing to forget: Inhibitory-control deficits compromise memory suppression in posttraumatic stress disorder. *Psychological Science, 26*(5), 604–616. https://doi-org.proxy-ub.rug.nl/10.1177/0956797615569889

Chen, S., Mao, X., & Wu, Y. (2022). Can't stop thinking: The role of cognitive control in suppression-induced forgetting. *Neuropsychologia, 172*, 1–10. https://doi-org.proxy-ub.rug.nl/10.1016/j.neuropsychologia.2022.108274

Hu, X., Bergström, Z. M., Gagnepain, P., & Anderson, M. C. (2017). Suppressing unwanted memories reduces their unintended influences. *Current Directions in Psychological Science, 26*(2), 197–206. https://doi-org.proxy-ub.rug.nl/10.1177/0963721417689881

Inquisit version 6.6.1. [Computer software]. (2022, July 7). Retrieved from https://www.millisecond.com

Lemhöfer, K., & Broersma, M. (2012). Introducing LexTALE: A quick and valid lexical test for advanced learners of English. *Behavior Research Methods, 44*(2), 325–343. https://doi.org/10.3758/s13428-011-0146-0

Levy, B., & Anderson, M. C. (2012). Purging of memories from conscious awareness tracked in the human brain. *The Journal of Neuroscience, 32*(47), 16785–16794. https://doi.org/10.1523/jneurosci.2640-12.2012

Myers, L. B. (2010). The importance of the repressive coping style: Findings from 30 years of research. *Anxiety, Stress & Coping: An International Journal, 23*(1), 3–17. https://doi-org.proxy-ub.rug.nl/10.1080/10615800903366945

OpenAI. (2024). ChatGPT 3.5. Retrieved January 2024, from https://openai.com/chatgpt

Qualtrics [Computer Software.] Qualtrics, Provo, Utah, https://www.qualtrics.com/

Stramaccia, D. F., Meyer, A.-K., Rischer, K. M., Fawcett, J. M., & Benoit, R. G. (2021). Memory suppression and its deficiency in psychological disorders: A focused meta-analysis. *Journal of Experimental Psychology: General, 150*(5), 828-850. https://doi.org/10.1037/xge0000971

Weiss, D.S., & Marmar, C.R. (1997). The Impact of Event Scale-Revised. In J.P. Wilson, & T.M. Keane (Eds.), *Assessing Psychological Trauma and PTSD: A Practitioner's Handbook* (pp. 399-411). New York: Guilford Press.

Wessel, I., Lehmann, R., & Wiechert, S. (2023). A Replication of Wiechert et al.'s (2023) Online Think/No-Think Study in the Lab. https://doi.org/10.31234/osf.io/m5kjy

Wiechert, S., Loewy, L., Wessel, I., Fawcett, J. M., Ben-Shakhar, G., Pertzov, Y., & Verschuere, B. (2023). Suppression-induced forgetting: A pre-registered replication of the think/no-think paradigm. *Memory*, *31*(7), 989-1002. https://doi.org/10.1080/09658211.2023.2208791

Zwaan, R. A., Pecher, D., Paolacci, G., Bouwmeester, S., Verkoeijen, P. P. J. L., Dijkstra, K., & Zeelenberg, R. (2018). Participant Nonnaiveté and the reproducibility of cognitive psychology. *Psychonomic Bulletin & Review, 25*(5), 1968–1972. https://doi.org/10.3758/s13423-017-1348-y

Appendix A

The Impact of Event Scale-Revised (Weiss & Marmar, 1997)

INSTRUCTIONS: Below is a list of difficulties people sometimes have after stressful life events. Please read each item, and then indicate how distressing each difficulty has been for you DURING THE PAST SEVEN DAYS with respect to _____, which occurred on _____. How much were you distressed or bothered by these difficulties?

Item Response Anchors are 0 = Not at all; 1 = A little bit; 2 = Moderately; 3 = Quite a bit; 4 = Extremely. The Intrusion subscale is the MEAN item response of items 1, 2, 3, 6, 9, 14, 16, 20. Thus, scores can range from 0 through 4. The Avoidance subscale is the MEAN item response of items 5, 7, 8, 11, 12, 13, 17, 22. Thus, scores can range from 0 through 4. The Hyperarousal subscale is the MEAN item response of items 4, 10, 15, 18, 19, 21. Thus, scores can range from 0 through 4. The items:

1. Any reminder brought back feelings about it.
2. I had trouble staying asleep.
3. Other things kept making me think about it.
4. I felt irritable and angry.
5. I avoided letting myself get upset when I thought about it or was reminded of it.
6. I thought about it when I didn't mean to
7. I felt as if it hadn't happened or wasn't real.
8. I stayed away from reminders of it.
9. Pictures about it popped into my mind.
10. I was jumpy and easily startled.
11. I tried not to think about it.
12. I was aware that I still had a lot of feelings about it, but I didn't deal with them.
13. My feelings about it were kind of numb.
14. I found myself acting or feeling like I was back at that time.
15. I had trouble falling asleep.
16. I had waves of strong feelings about it.
17. I tried to remove it from my memory.
18. I had trouble concentrating.
19. Reminders of it caused me to have physical reactions, such as sweating, trouble breathing, nausea, or a pounding heart.

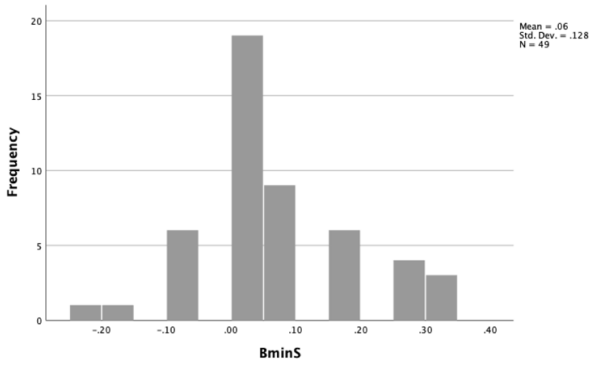
20. I had dreams about it.
21. I felt watchful and on-guard.
22. I tried not to talk about it.

Appendix B

Suppression Induced Forgetting Effect Assumption Checks

Figure 3

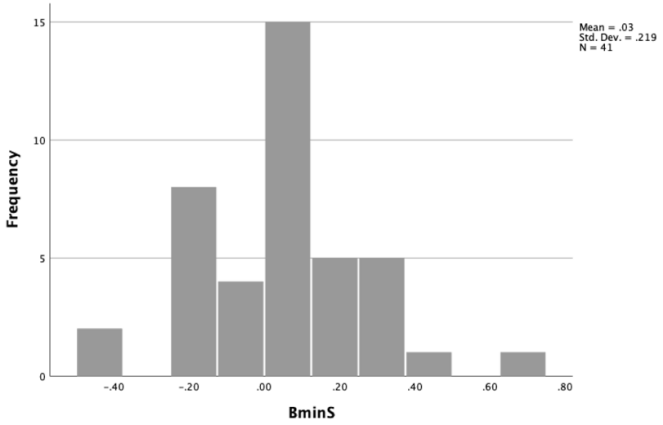
Histogram of the Distribution of the Difference Score Between Baseline and Suppression Items in the In-Lab Setting



Note: The division of the difference score illustrates a normal distribution of the data, characterized by the symmetrical bells-shaped curve. The majority of the scores is clustered around the mean and decreases in frequency when it moves away from the center.

Figure 4

Histogram of the Distribution of the Difference Score Between Baseline and Suppression Items in the Online Setting

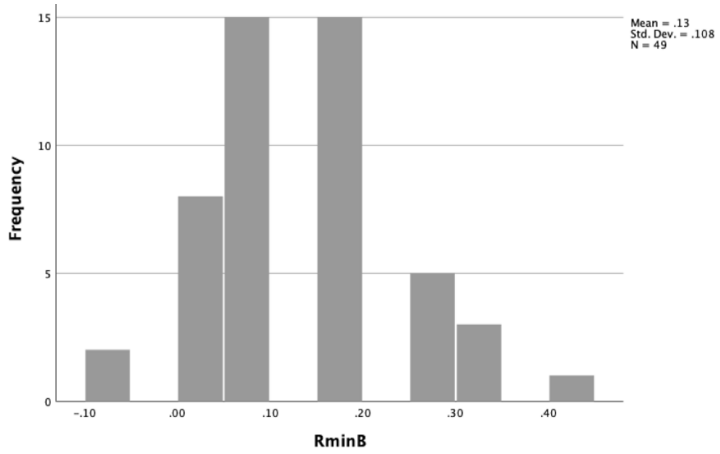


Note: The division of the difference score illustrates a normal distribution of the data, characterized by the symmetrical bells-shaped curve. The majority of the scores is clustered around the mean and decreases in frequency when it moves away from the center.

Positive Control Effect Assumption Checks

Figure 5

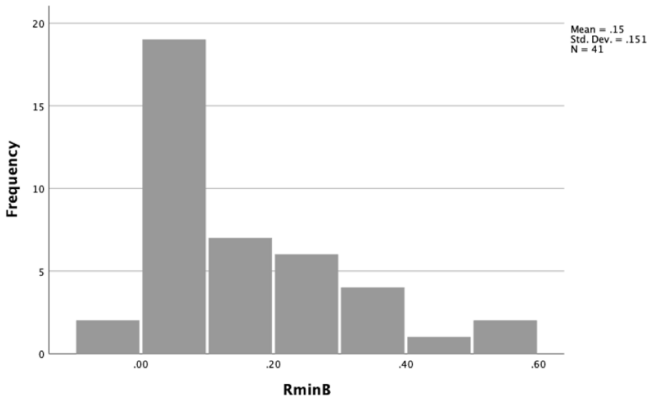
Histogram of the Distribution of the Difference Score Between Recall and Suppression Items in the In-Lab Setting



Note: The division of the difference score illustrates a normal distribution of the data, characterized by the symmetrical bells-shaped curve. The majority of the scores is clustered around the mean and decreases in frequency when it moves away from the center.

Figure 6

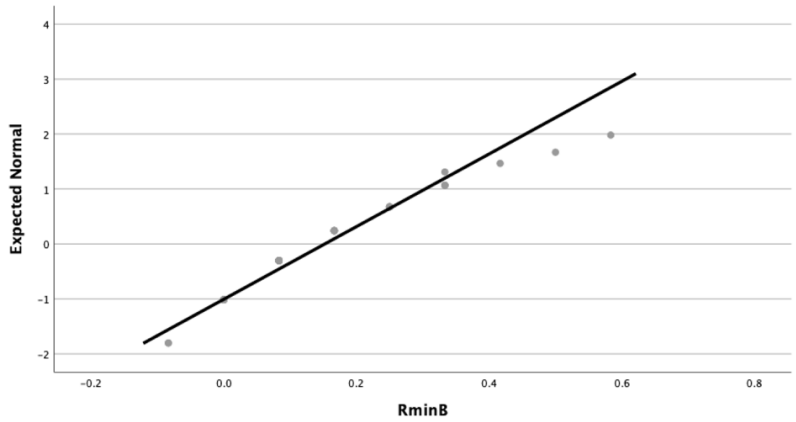
Histogram of the Distribution of the Difference Score Between Recall and Suppression Items in the Online Setting



Note: The division of the difference score seems to illustrate a normal distribution of the data, characterized by the symmetrical bells-shaped curve. But it is not clear enough make a statement about the distribution.

Figure 7

Quantile-Quantile Plot of the Distribution of the Difference Score Between Recall and Suppression Items in the Online Setting

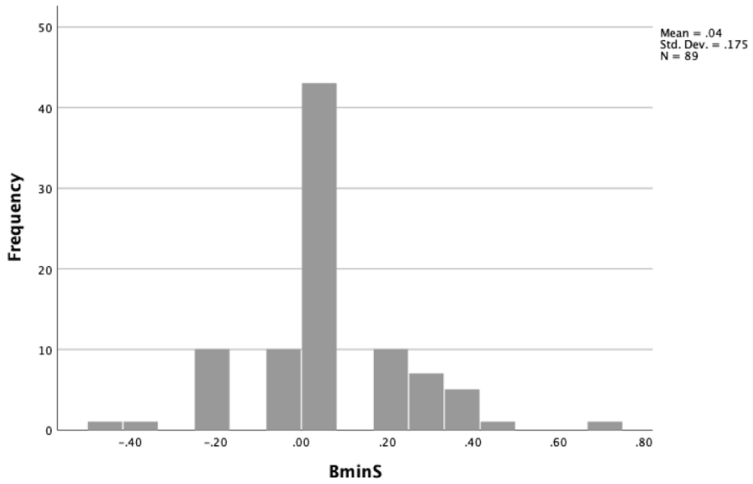


Note: The Q-Q plot demonstrates a close alignment of the data point with the diagonal line, this indicates a conformity to a normal distribution

Relation Between suppression of Memories and Intrusive Memories Assumption Check

Figure 8

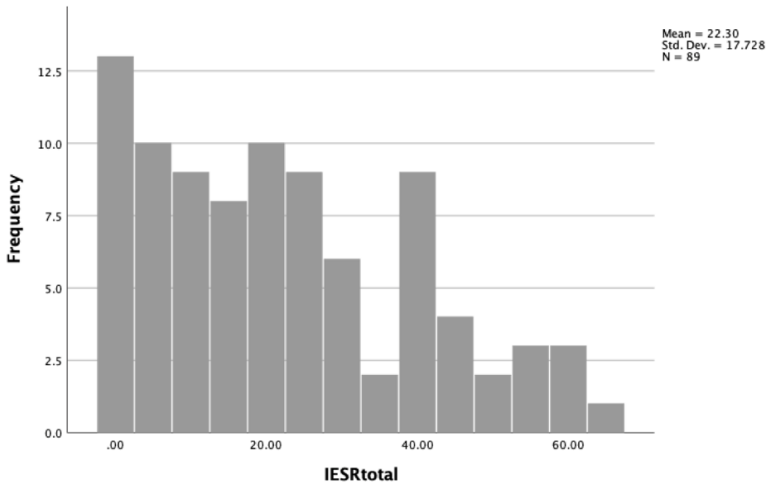
Histogram of the Distribution of the Difference Score Between Baseline and Suppression Items in the Total Sample



Note: The division of the difference score illustrates a normal distribution of the data, characterized by the symmetrical bells-shaped curve. The majority of the scores is clustered around the mean and decreases in frequency when it moves away from the center.

Figure 9

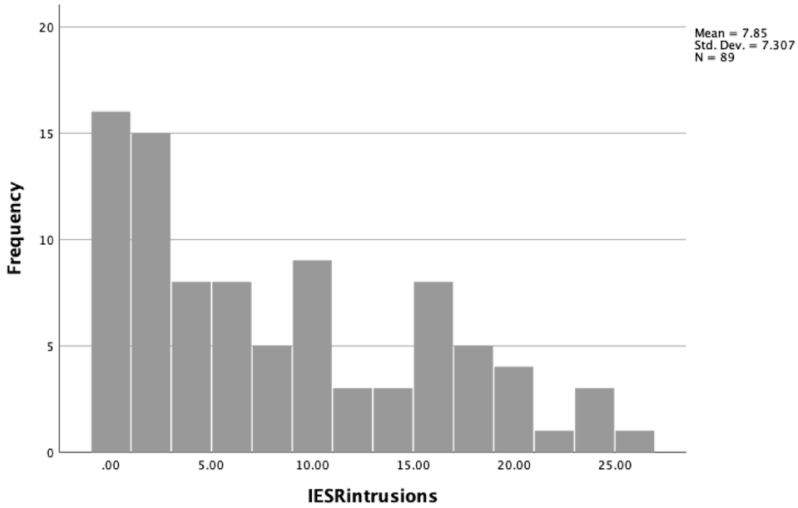
Histogram of the total scores on the IES-R questionnaire



Note: The division of the total score on the IES-R questionnaire differs from the symmetrical bell-shaped curve that is characteristic of a normal distribution. The majority of the observations is clustered to the left instead of around the mean, and the frequency seems to decrease when looking at the higher IESR scores.

Figure 10

Histogram of the scores on the intrusion scale of the IES-R questionnaire



Note: The division of the scores on the intrusion scale of the IES-R questionnaire differs from the symmetrical bell-shaped curve that is characteristic of a normal distribution. The majority of the observations is clustered to the left instead of around the mean, and the frequency seems to decrease when looking at the higher IESRintrusion scores.

Appendix C

Finding Possible Outliers

Extreme outliers are defined as difference scores that are smaller than the first quartile by three times the interquartile range (IQR) and larger than the third quartile by three times the interquartile range.

Suppression induced Forgetting Effect

The difference score between suppression and baseline items showed no outliers. In the in-lab setting the IQR was .17, three times this IQR is .51. The first quartile is 0 and the third quartile is .167. Extreme outliers would then be smaller than -.51 or larger than .6767. There were no scores found met this definition.

The difference score between suppression and baseline items showed no outliers. In the online setting the IQR was .29, three times this IQR is .87. The first quartile is -.125 and the third quartile is .167. Extreme outliers would then be smaller than -.995 or larger than 1.037. There were no scores found met this definition.

***Positive Control Effect*:**

The difference score between suppression and recall items showed one outlier. In the in-lab setting the IQR was .08, three times this IQR is .24. The first quartile is .0833 and the third quartile is .1667. Extreme outliers would then be smaller than -.1567 or larger than .4067. There was one score found that met this definition, with a score of .42, and therefore was removed from the analysis.

The difference score between recall and baseline items showed no outliers. In the online setting the IQR was .21, three times this IQR is .63. The first quartile is .0417 and the third quartile is .25. Extreme outliers would then be smaller than -.5883 or larger than .88. There were no scores found met this definition.

Relationship Between Suppression of Memories and Intrusive Memories

The difference score between suppression and baseline items showed no outliers. The IQR was .21, three times this IQR is 631. The first quartile is -.0208 and the third quartile is .1667. Extreme outliers would then be smaller than -.6508 or larger than .7967. There were no scores found met this definition.

The score on the IES-R questionnaire showed no outliers. The IQR was 32, three times this IQR is 96. The first quartile is 6 and the third quartile is 38. Extreme outliers would then be smaller than -90 or larger than 134. There were no scores found met this definition.

The score on the IES-R questionnaire with only intrusion items, showed no outliers. The IQR was 13.50, three times this IQR is 40.50. The first quartile is 1 and the third quartile is 14.50. Extreme outliers would then be smaller than -39.5 or larger than 55. There were no scores found met this definition.