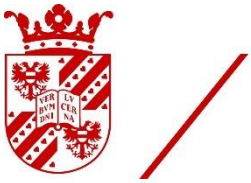


rijksuniversiteit groningen

Exploring Suppression-Induced Forgetting in Relation to Resilience: A Replication Study of the Think/No-Think Paradigm

J.L.M. Kuipers

Master Thesis – Clinical Forensic Psychology and Victimology

S4010175
April 2024
Department of Psychology
University of Groningen
Examiner/Daily supervisor: J. P. Wessel

Abstract

The current study replicated Wiechert et al. (2023) by investigating suppression-induced forgetting (SIF) using the Think/No-Think (TNT) paradigm and explores the potential relationship of SIF with resilience. In Wiechert et al.'s (2023) study they did not find a significant SIF-effect in their online study, while previous research did find a significant SIF-effect in an in-person environment. Given this discrepancy, the current study examines the SIF-effect across online and in-person environments. Participants online and in-person were expected to recall significantly fewer No-Think targets than baseline (SIF-effect) and more Think targets than baseline (positive control effect). The study also expected a positive relationship between SIF and resilience, based on the cognitive model of resilience by Parson et al. (2016). Ninety first-year bachelor students of the University of Groningen completed the TNT-task either online (N = 41) or in-person (N = 49). Contrary to expectations, a significant SIF-effect was observed only in the in-person condition, with participants recalling fewer No-Think targets than baseline. A positive control effect was observed in both the online and in-person condition, indicating successful active recall of Think targets. No significant relationship was found between resilience and SIF. The findings suggest that the SIF-effect might be context dependent, as the effect did show in an in-person setting but not in an online setting. This highlights the methodological challenges associated with online implementations of the TNT-paradigm. The study's implications emphasize considering environmental contexts when investigating SIF. While no significant relationship between resilience and SIF was observed, future research should explore further the mechanisms involved in memory suppression and its implications for interventions aimed at enhancing resilience.

Keywords: think/no-think paradigm, suppression-induced forgetting, replication, resilience

Exploring Suppression-Induced Forgetting in Relation to Resilience: A Replication Study of the Think/No-Think Paradigm

To reduce emotional distress caused by for instance a traumatic event, individuals need to deliberately control their memory, for example by suppressing unwanted memories (Chen et al., 2022). This skill is based on a proposal by Freud that unwanted memories can be forgotten by pushing them into the unconscious, a process called repression (Anderson & Green, 2001). According to Anderson & Green (2001), when individuals encounter cues that remind them of an unwanted memory and consistently attempt to avoid awareness of it, the recall of the rejected memory becomes more difficult. The likelihood of forgetting increases with the number of times the memory is avoided. To examine the hypothesis of suppression, Anderson & Green (2001) introduced the Think/No-Think (TNT) paradigm, which was implemented in several studies (e.g., Anderson & Green, 2001; Anderson et al., 2004; Joormann et al., 2005; Hertel et al., 2012; Chen et al., 2022, Wiechert et al., 2023, Wessel et al., 2023).

The Think/No-Think Paradigm

The TNT-task (as it was executed by Wiechert et al., 2023) consists of three main phases, including a learning phase, the TNT-phase, and the testing phase. During the learning phase, participants are instructed to learn and memorize word-pairs (cue-target pairs), for example WAFFLE-MAPLE. After the learning phase the participants will immediately be tested on their memory of these word-pairs and the task continues when the participant has successfully retained all individual word-pairs. After the learning phase the actual TNT phase starts. During this phase, the participants are instructed to either think about the associated word (respond condition; Think; e.g., WAFFLE-MAPLE) or not think of the associated word of the cue-target pairs (suppression condition; No-Think). During this phase, the respond condition words are presented in green, whereas the suppression target words are presented in

red. There will also be some baseline targets that are not presented during this phase. In the last and final phase of the task participants are tested on their memory of all the word-pairs they learned in the beginning. Where a diminished recall of the No-Think items compared to the baseline items indicates support for suppression-induced forgetting (SIF) (Wiechert et al., 2023). Suppression-induced forgetting entails, as described by Wiechert et al. (2023), an ability to block memories from entering conscious awareness through active suppression, which hinders later retrieval of that memory.

Replication of Wiechert et al. (2023)

Recent research by Wiechert et al., (2023) focused on investigating suppression-induced forgetting in an online-experimenter present version. Their aim was to replicate previous findings (e.g., Anderson et al., 2004; Joormann et al., 2005) of a significant suppression-induced forgetting effect using the TNT-task. They used a sample of 150 English-speaking healthy individuals. Contrary to the previous findings, Wiechert et al. (2023) did not replicate the SIF-effect in their study. This discrepancy with previous research underscores a need for further investigation into suppression-induced forgetting. It questions the robustness of the effect, particularly in an online implementation of the TNT-task.

Resilience and the SIF-effect

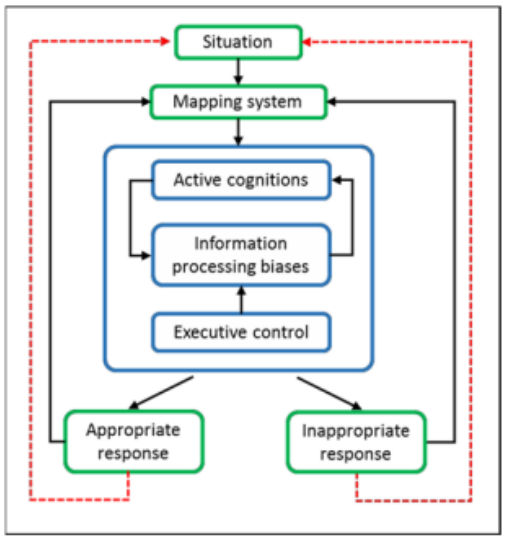
The ability to suppress unwanted memories, as studied in SIF-studies, may overlap with aspects of emotion regulation and resilience. Individuals who are better at suppressing unwanted memories, could possibly also be better at adapting to stressful situations and setbacks, which is a characteristic of resilient individuals. Therefore, the current study examines the ability to suppress unwanted memories and its potential relationship with resilience. Resilience is the result of a successful adaptation to stressors (Dolezal, 2021). The essence of resilience is that certain individuals manage stressful experiences more effectively than anticipated (Parson et al., 2016). It is also the ability to successfully adapt to difficult or

challenging experiences through mental, emotional, and behavioural flexibility (American Psychological Association, n.d.). It is a protective factor and personal ability that could be fostered to enhance one's resilience to overwhelming stress (Wu, 2023).

Parson et al. (2016) proposed a cognitive model to depict the relationship between resilience and cognitive processes. It focuses on the ability to flexibly apply appropriate cognitive processing in the relevant situations. The model is displayed in Figure 1. The model highlights implicit cognitive processes like executive control, information biases, and active cognitions. But it also introduces another aspect: a certain mapping system that guides flexible information processing according to situational demands and goals. The model is about adjusting strategies in certain situations. When certain responses deem ineffective (e.g., in managing stress), this model promotes flexibility in cognitive processing to adjust strategies. Thus, according to this model, resilience involves the ability to flexibly adapt cognitive processes to adjust strategies in response to situational demands and goals. This suggests that individuals who are more resilient, should demonstrate greater cognitive flexibility.

Figure 1

Information-Processing Model of Psychological Resilience



Note: reprinted from “A Cognitive Model of Psychological Resilience”, by Parson, S., Kruijt, A., & Fox, E., 2016, *Journal of Experimental Psychopathology, 7*, 299.

The TNT-task assesses cognitive flexibility and control. In the TNT-task participants need to respond to specific stimuli which appear on the computer screen while trying to ignore other stimuli. While the TNT-task measures the speed and accuracy of the responses, it is also believed to tap into executive functions and memory control, which are crucial aspects of cognitive flexibility (Anderson & Green, 2001). Individuals who perform well on the TNT-task are likely to exhibit higher levels of cognitive flexibility, as they can quickly switch attention between relevant and irrelevant information. This aligns with the concept proposed by Parson et al. (2016). Moreover, research by Anderson and Hulbert (2021) suggests that organisms can adapt their memories to align with cognitive and emotional goals. This aligns with the notion that cognitive flexibility, as measured by tasks like the TNT-task, may play a role in controlling unwanted memories, which is a crucial aspect of emotional regulation and mental health maintenance (Chen et al., 2022).

Individuals with higher resilience scores, according to Parson et al.’s (2016) model, are expected to possess greater cognitive flexibility. When these individuals are presented with tasks like the TNT-task, which measures cognitive flexibility, they are likely to perform better due to their enhanced ability to switch attention between relevant and irrelevant stimuli. The cognitive flexibility exhibited by resilient individuals may facilitate their capacity to suppress unwanted memories, aligning with cognitive and emotional goals. Therefore, it is suggested that individuals with higher resilience scores, will perform better on the TNT-task, indicating greater cognitive flexibility. It may reflect their enhanced ability to control unwanted memories, thus reinforcing the link between resilience, cognitive flexibility, and the SIF-effect. These connections could strengthen the theoretical foundation of resilience and

cognitive control and explore the potential of the TNT-task as a measurement tool of resilience.

The Current Study

The current study aims to replicate the research conducted by Wiechert et al. (2023) and add to the literature of suppression-induced forgetting. Wiechert et al. (2023) did not find support for the SIF-effect in an online setting. To enhance the generalizability of the TNT-task and examine the effect across different settings, the current study implemented the TNT-task in an online setting and in an in-person setting, unlike Wiechert et al.'s (2023) study, which was exclusively online. As several previous studies have provided support for the SIF-effect in in-person implementations of the task (e.g., Anderson & Green, 2001; Anderson et al., 2004; Joormann et al., 2005; Hertel et al., 2012; Chen et al., 2022, Wessel et al, 2023), it was expected that the SIF-effect would be observed in both the online and in-person condition, therefore the study aims to provide additional support for the SIF-effect.

Additionally, while conducting this replication, the current study also explores the relationship between resilience and memory suppression using the TNT-task and the *Resilience Evaluation Scale* (Van Der Meer et al., 2018). While examining the potential relationship between resilience and SIF, the aim is to gain a deeper understanding of psychological resilience and cognitive processes relevant to emotional processing. It aims to investigate the potential relationship between differences in resilience and variations in the ability to suppress memories.

Based on the aforementioned connections, the following hypotheses have been formulated:

Hypothesis 1a: Participants online and in-person are expected to recall significantly fewer No-Think targets than baseline targets (SIF-effect).

Hypothesis 1b: Participants online and in-person are expected to recall significantly more Think targets than baseline targets (positive control-effect).

These two expectations are based on the literature that has found support for the SIF-effect (e.g., Anderson & Green, 2001; Anderson et al., 2004; Joormann et al., 2005; Hertel et al., 2012; Chen et al., 2022, Wessel et al., 2023) and a positive control effect (Wessel et al., 2023, Wiechert et al., 2023). For the current study only the same-probe task will be measured to assess SIF and the positive-control effect.

Hypothesis 2: Individuals with higher resilience scores are expected to perform better on the TNT-task. This is supported by the concept that resilience involves cognitive flexibility, a trait linked to memory control in tasks like the TNT. The relationship suggests that higher resilience could be associated with enhanced SIF, indicating a potential positive relationship between resilience and the SIF-effect.

Method

Statement of Transparancy

The hypotheses, method, and data analysis plan were pre-registered and shared on the Open Science Framework (OSF), as was the anonymized dataset (https://osf.io/gsa58/). There were no deviations from the preregistration.

Participants

There were several inclusion criteria in the study including participants being aged between 18 and 45 years old, having normal or corrected to normal eyesight, not being colourblind for the colours red and green, and not having a severe form of dyslexia or a current mental disorder. There were several exclusion criteria for the conditions during the experiment. This included not completing specific parts of the experiment (i.e., same-probe test, and compliance screening); failing to accurately react to 75% of the trials during the think/no-think phase; failing to learn all the word-pairs within the time limit of 25 minutes; if

they had a total score of above 4 (out of a total of 12) on the compliance screening (a so called cheater score); and if they had selected “Very much” on either of the distraction questions in the Session Evaluation Questionnaire. A total of 105 individuals participated in the experiment. Of these 105 participants, 15 were excluded due to the following reasons: a cheater score (1 in-person, 5 online), presence of mental disorder (3 in-person, 1 online), exceeding the learning time of 25 minutes (1 in-person, 2 online), experiencing a bad internet connection (1 online), and a data failure (1 online). The excluded participants would be replaced to eventually reach a goal sample size with only valid participants. After the exclusions a final sample size of 90 participants was left. The next results emerged for the demographic information. The mean age of the participants was 21 years, ranging from 18 to 36 years old. The sample consisted of 24 males (26.7%), 63 females (70.0%), 1 non-binary/third gender (1.1%) and 1 participant who chose not to disclose their gender (‘prefer not to say’ in the questionnaire; 1.1 %). In the study 12 participants (13.3%) reported English as their native language, 26 (28.9%) reported Dutch, and 17 (18.9%) reported German. 34 participants (37.8%) reported ‘other language’ consisting of Amazigh, Chinese, Finnish, Hungarian, Indonesian, Tamil, Germanic languages, Indo-European languages and Slavic languages.

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

Design and Power Analysis

A one-factor within-participant design with three levels of instruction condition was used: Think, No-Think and Baseline. The sample size was determined based on the study of Wessel et al. (2023), which also replicated Wiechert et al.’s (2023) study. They employed G*Power (Faul et al., 2009) for an a priori sample size calculation. A power analysis with a one-sided $\alpha = .025$ revealed that $N = 54$ would be required for a medium effect size (Cohen’s

d = 0.5) with a power of .95. Since the current study examined both in-person (*N* = 54) and online (*N* = 54) conditions, this results in a total number of *N* = 108 participants. Due to a time limit for testing participants a total of *N* = 41 participants were assessed online and *N* = 49 participants were assessed in-person. Which resulted in a total sample of *N* = 90 participants.

Material

The materials, excluding the exploratory measures and the independent-probe task, were adopted from Wiechert et al.'s (2023) study (see https://doi.org/10.1080/09658211.2023.2208791). The TNT-task required participants to learn target word-pairs and follow task instruction. The same-probe task was administered during the last phase of the TNT-task, to assess participants' knowledge of the word-pairs. The TNT-task, including the Diagnostic Questionnaire, was conducted using Inquisit Lab (version 6.6.1 [Computer software], 2022). In addition to the TNT-task, various questionnaires were administered via Qualtrics (*Qualtrics XM – Experience Management Software*, 2024). The questionnaires included a compliance screening, measuring whether the participant made an effort to think about the response for the red hint words, with participants scoring above 4 points being excluded. Included was a strategy check, where the participants indicate which strategy they used when encountering a red hint word. Lastly, a distraction questionnaire was assessed, measuring how distracted participants were during the task. Those indicating distraction by selecting 'very much' on either 'I'm in a noisy environment' or 'There are a lot of distractions here' were excluded.

Following these initial questionnaires, the questionnaires of the researchers' personal research questions were presented, which are in order the following: Trauma History Questionnaire (THQ), Impact of Events Scale-Revised (IES-R), Resilience Evaluation Scale (RES), Emotion Regulation Questionnaire (ERQ) and the Levenson Self-Report Psychopathy

Scale (LSRP). For the current study only the *Resilience Evaluation Scale* (Van Der Meer et al., 2018; RES) will be used to address the research question.

The RES is a 9-item questionnaire to measure resilience, with items like “I can easily adjust to difficult situations”. All items carry a 5-point range of responses from completely disagree (0) to completely agree (4). This 9-item questionnaire is based on the 25-item Resilience Scale (Wagnild & Young, 1993) which measures equanimity (a balanced perspective of one's life and experiences), perseverance (being able to keep going despite difficulties), self-reliance (the belief in oneself and one's capabilities), meaningfulness (feeling that life has a purpose and life is valuable) and existential aloneness (sense of uniqueness, feeling of freedom) (Van Der Meer et al., 2018). The questionnaire had a good internal consistency (α = .84). The complete questionnaire is added in Appendix A.

Besides these questionnaires, demographic questions were asked, namely the age of the participant, their gender and their native language.

Procedure

The study was conducted in English by four MSc students from the programme Clinical Forensic Psychology and Victimology and one second year Bachelor of Psychology Student. All experimenters scored the equivalent of C1 & C2 level on an English language proficiency, which is >80% on the LexTale test by Lomhöfer and Broersma (2012). The experimenters demonstrated 100% accuracy in recalling all word-pairs and underwent training sessions from the senior experiments of Wiechert et al.’s (2023) study. Furthermore, the experimenters passed a final mock trial evaluation session conducted by the lead author of the original study (Wiechert et al, 2023). Additionally, halfway through testing each individual experimenter was evaluated by the senior experimenter from the original study.

In the current quantitative study, the participants were gathered through a recruitment system called SONA. Through this system, first-year bachelor students at the University of

Groningen could sign-up for the study in exchange for 2.6 SONA credits. The advertisement did not mention the phrase “memory” but labelled the task as an “attention” task, to not reveal the true purpose of the study. The online and in-person conditions were randomly allocated to show up on the participants SONA page. Which conditions the participant would be tested (online or in-person) was based on the last two digits of their telephone number. Participants whose telephone number ended between 01-20 and 41-60 could only sign up for the in-person condition, whereas participants whose phone number ended between 21-40, 61-80 or 81-00 could only sign up for the online condition. The 53 word-pairs in the current study were adopted from the study of Anderson and Green (2001) and distributed across three categories (Think, No-Think, and Baseline). Of these three categories, three different versions of the TNT-task were made (A, B, and C), to ensure that each participant does not encounter the same word pairs in Think, No-Think, and Baseline during the different phases of the experiment. Google’s AI chatbot Gemini was asked to make different orders of A-B-C so the researchers would test the participants at random.

Procedure of the In-Person and Online Condition

Before starting the in-person session the researcher connected their designated computer to the participant’s computer using the desktop application Anydesk (Anydesk, 2022). For the online condition Google Meet (Google, n.d.) was used, with each participant receiving a personalized URL to the session. In the in-person condition, the participant’s mouse and keyboard were removed as they were not required for the task, and the participant’s computer screen was turned off. For the online condition, it was essential to ensure that the participant’s camera and microphone were functioning properly. Participants were asked to minimize potential distractions by answering a few questions, such as “Is it noisy in the background of the participant?” and “Is it busy in the background of the

participant?". In both conditions the participants were asked to turn of their phone, to minimize distractions during the task.

In both conditions, inclusion criteria were assessed before the participants were asked to read the research information letter and the consent form, and sign it twice: once for the researcher and once for the participant to take home. In the in-person condition, this was done by a printed format, in the online condition a Qualtrics link to the research letter and informed consent was sent via the Google Meet chat-function. Participants had to download the form, consent to the study, and notify the researcher when they had signed. In the in-person condition the participant then gave one consent form to the researcher. In the online condition the researcher would confirm the participant's consent in the data before continuing the session. Upon obtaining consent, instructions for the task were provided. The participant's screen was activated in the in-person condition, or the researcher started sharing their screen for the online-condition. Once the instructions were given, the researcher exited the room and conducted the TNT-task from an adjacent room, while the door remained open (in-person condition), or the researcher turned of their camera (online condition). Throughout the task, the researcher followed a script, and both the participant and the researcher read the information on their own screens. Participants provided verbal responses to cues, which were coded by the researcher. Upon completion of the task, participants were instructed to complete the questionnaires via Qualtrics. In the in-person condition the researcher would open the questionnaires, in the online condition a link to the questionnaires was sent in the chat-function.

Procedure of the Think/No-Think Task

The Think-No/Think-task has 6 phases: 1.) the learning phase; 2.) the test-feedback phase; 3.) practice Think/No-Think (TNT); 4.) the actual TNT ('attention task'); 5.) the same-probe test and 6.) the compliance screening and end-of-study questionnaires. These phases

consisted of the following, in the same manner as that of Wiechert et al. (2023) regarding the same-probe recall phases.

(1) During the *learning phase* participants were presented with 54 individual cue-target pairs (e.g., WAFFLE-MAPLE) at the centre of the screen. They were instructed to memorize these, as they will be asked to recall them later on.

(2) In the *test-feedback phase* participants were asked to recall the cue-target pairs using a drop-off procedure. If the participant correctly recalled the associated word, the word-pair would not appear again. If the participant was not able to mention the associated word, the correct answer was revealed in blue, and the word would appear again later. This process continued until the participant achieved 100% accuracy or reached the time limit of 25 minutes, in which case the participant had to be excluded. Throughout this phase and subsequent phases, the experimenter coded the responses using their keyboard.

(3) In the *practice TNT* situation, the participants received on-screen and verbal instructions. Cues were presented individually on the computer screen, with Think cues shown in green, prompting participants to mention the associated target. The No-Think items would appear in red, indicating to suppress any thoughts of the associated target. Participants received feedback with the correct associated word in blue if they could not recall the associated green word within 5 seconds. If the participants did say something during a No-Think item, an error message would appear reminding them about the task. This practice phase consisted of 48 trials with 12 filler pairs, in which both the six No-Think and Think cues were presented four times each. The lists of the 12 word-pairs were counterbalances across the different conditions: Think, No-Think and Baseline conditions, resulting in three different versions (A, B and C). After the practice TNT the participant would be presented with a *diagnostic questionnaire*. The participant and experimenter went through this questionnaire together. This questionnaire was meant to observe if the participant understood

the task and could repeat and clarify the TNT instructions if necessary. Example questions of the diagnostic questionnaire are: ‘For the green cue words, how often did you try to come up with the associated responses as FAST as possible’ and ‘When you looked at the RED hint word, how often did you read and understand it?’. The participant needed to score on a scale from ‘never’ (0) to ‘always’ (4).

(4) The *Think/No-Think phase* is the same as the practice TNT phase, except that the participant would now be presented with 12 repetitions of 24 cues (12 No-Think, 12 Think), which resulted in 288 critical trials (thus 144 No-Think and 144 Think trials). The trials were divided into three blocks of 96 trials, with a one-minute rest period in between. Halfway through the TNT phase the same diagnostic questionnaire as before was presented, to examine if the participant still understood the task.

(5) Lastly the participant would be presented with the *same-probe test*. In this phase participants were tested on their memory of the word-pairs while randomizing the order across the participants. Participants were asked to respond to all the cues, even if some were red in the previous phase. During this phase the participant would not receive any blue feedback if they forgot the associated word.

(6) In the *compliance screening and end-of-session questionnaire phase* a session evaluation questionnaire and a compliance screening were measured and administered through Qualtrics. After these questionnaires, the individual experimenter questionnaires were presented. The participant was instructed to use their own keyboard. In the in-person conditions the experimenter would turn their own screen off due to privacy reasons. In the online condition the experimenter would turn off their camera and microphone. The participants were asked to notify the experimenter when they were done. After completion the participants were thanked for participating in the study and received their SONA credits. They received a short debriefing to prevent participants from influencing other participants.

Statistical Analysis

The data was fully anonymised before the statistical analysis, this process ensured that the dataset is stripped from all identifying information of the participants (e.g., age, gender, native language). The analyses were done on both samples (online and in-person), separately for the first hypotheses (N = 49 in-person condition; N = 41 online condition). For the personal research question, the analysis was conducted on the whole sample (N = 90). Invalid data due to exclusion was removed from the dataset used for the analysis. The analyses were done using the statistical software *Statistical Package for the Social Sciences* (SPSS).

In testing for the SIF-effect and positive control effect, frequentist one-tailed paired samples t-test procedures were used. For the first hypothesis, the dependent variable was the proportion of correct recall, with the independent variable being the baseline and suppression condition. Similarly, for the second hypothesis, the dependent variable remained the proportion correct recall, while the independent variables were the baseline and response condition. For this t-test the following assumptions needed to be met: 1.) a continuous dependent variable; 2.) independence of observations; 3.) normally distributed dependent variable; 4.) absence of outliers. The normality assumption was examined using QQ-plots and histograms for both the in-person and online condition. Outliers were examined, where an outlier is defined as more than three times the interquartile range from the first and third quartiles. Potential outliers were removed from the dataset. All the t-tests were assessed with $\alpha = .05$. For these assumption checks new variables have been created (SIF-effect and positive control effect) and the checks were done on both the in-person and online condition.

The next hypothesis is that it was expected that people who score high on the *Resilience Evaluation Scale* would perform better at the TNT-task. This would indicate a positive relationship between resilience and the SIF-effect. This hypothesis was tested using a Spearman correlation, as the questionnaire was measured on an ordinal scale. Using the total

scores of the participants on the RES and the variable for the SIF-effect (*proportion correct baseline – proportion correct suppression*). For the Spearman correlation the following assumptions had to be met: 1.) the data had to be measured on an ordinal scale (ordinality); 2.) the data exhibited a consistent directional relationship between variables (monotonicity); 3.) absence of outliers; 4.) each pair of observations must be unique; 5.) and the observations needed to be independent.

Results

Hypothesis 1a and Hypothesis 1b

For hypothesis 1a the SIF-effect was examined. A few assumptions have been met for the analysis, where the assumption of normality was not violated as seen by the almost equal distribution of values. The figures are shown in Appendix B, with Figure B1 and B2 for the SIF-effect and Figure B3 and B4 for the positive control effect. The dependent variable was continuous, and the sample consisted of independent observations. For the in-person condition the test reported a statistically significant lower proportion recall of No-Think (M = 80.44%, SD = 14.89%) than Baseline targets (M = 86.22%, SD = 10.56%; $t(48) = -3.17$, $p = .001$, Cohen's $d = -.45$, 95% CI [-0.09; -0.02]). Meaning that the null hypothesis was rejected for the in-person condition. In the online condition the test did not show a statistically significant lower proportion recall of No-Think (M = 80.28%, SD = 17.56%) than Baseline targets (M = 82.93%, SD = 15.25%; $t(40) = -0.77$, $p = .222$, Cohen's $d = -0.12$, 95% CI [-0.10; 0.04]). Indicating that the null hypothesis was rejected for the online condition. For an overview of the average values and standard deviations tables are presented in Appendix C, with Table C1 for the in-person condition and Table C2 for the online condition.

In Hypothesis 1b the positive control effect was examined. Once again, a one-tailed paired sample t-test was employed to examine this hypothesis. The assumption of normality was not violated as seen by the almost equal distribution of values. The figures are shown in

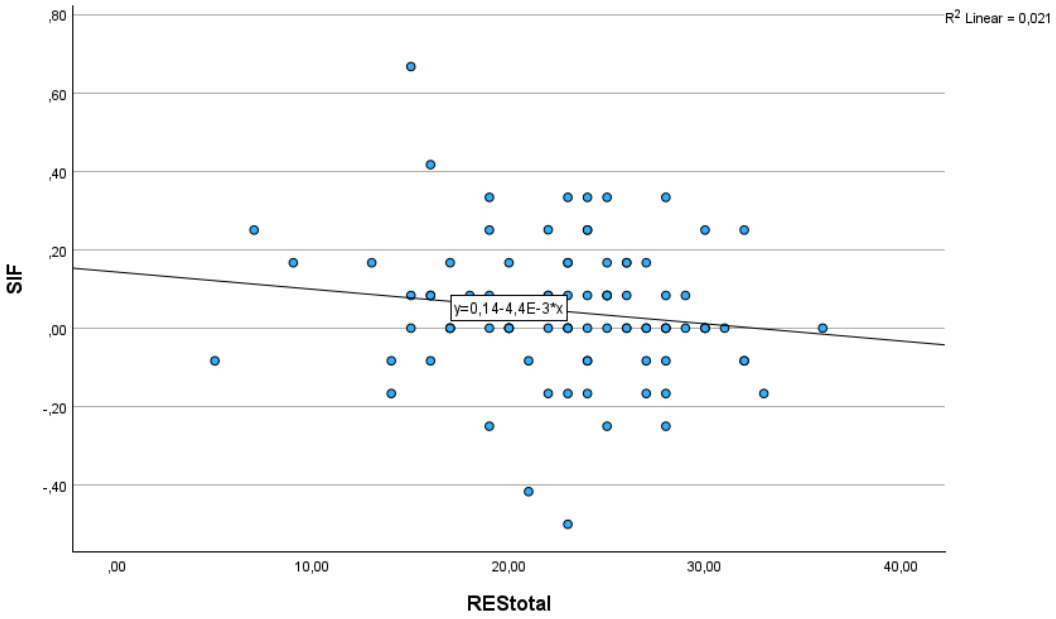
Appendix B, with Figure B5 and B6 for the SIF-effect and Figure B7 and B8 for the positive control effect. The analysis showed a statistically significant higher proportion recall of Think (M = 98.98%, SD = 2.76%) than Baseline targets (M = 86.22%, SD = 10.56%; $t(48) = 8.29$, $p < .001$, Cohen's d = 1.18, 95% CI [0.10; 0.16]) for the in-person condition. The analysis also showed a statistically significant higher proportion recall of Think (M = 98.17%, SD = 5.11%) than Baseline targets (M = 82.93%, SD = 2.38%; $t(40) = 6.45$, $p < .001$, Cohen's d = 1.01, 95% CI [0.10; 0.20]) for the online condition. Thus, the tests show support to reject the null hypotheses. For an overview of the average values and standard deviations tables are presented in Appendix C, with Table C3 for the in-person condition and Table C4 for the online condition.

Hypothesis 2

In hypothesis 2 the potential positive relationship between resilience and SIF was examined using a Spearman correlation. For this correlation several assumptions were met: the variables were measured on an ordinal scale; there was monotonicity; it did not have any outliers; each pair of observations was unique; and the observations were independent. The relationship between RES and SIF was not significant ($r(88) = -.125$, $p = .245$). It might have been possible that the environment (in-person or online) could have influenced the relationship between SIF and resilience. Therefore, to examine this possible difference in relationship, two explorative correlations were conducted. Here it was concluded that both in the in-person condition ($r(47) = -.233$, $p = .107$) and in the online condition ($r(38) = -.0.91$, $p = .576$) there was no significant relationship between SIF and resilience. The correlation of the in-person condition is displayed in Figure C1 and the correlation of the online condition is displayed in Figure C2 in Appendix C.

Figure 2

Scatterplot Resembling the Relationship Between Resilience and SIF



Note: REStotal contains the total scores of resilience on the *Resilience Evaluation Scale* (Van Der Meer et al., 2018).

Discussion

The current study replicated the study of Wiechert et al. (2023) and made an attempt to replicate the findings of a significant SIF-effect found in previous studies (e.g., Anderson & Green, 2001; Anderson et al., 2004; Joormann et al., 2005; Hertel et al., 2012; Chen et al., 2022, Wessel et al., 2023). The following hypotheses were expected: 1a.) participants online and in-person are expected to recall significantly fewer No-Think targets than baseline targets (SIF-effect); 1b.) participants online and in-person are expected to recall significantly more Think targets than baseline targets (positive control-effect); 2.) a positive relationship between resilience and the SIF-effect was expected.

Suppression-Induced Forgetting Effect

It was expected that the SIF-effect would persist in both the online and in-person conditions. Interestingly, while the analyses revealed a significant SIF-effect in the in-person condition, it was not observed in the online condition. This aligns the results of Wiechert et

al.'s (2023) which also did not find a significant results in the online implementation of the TNT-task. The significant findings in the in-person condition further support the existence of a SIF-effect in an in-person (lab) setting, consistent with previous research (e.g., Anderson & Green, 2001; Anderson et al., 2004; Joormann et al., 2005; Hertel et al., 2012; Chen et al., 2022, Wessel et al., 2023).

One explanation for the discrepancy between in-person and online might be that participants in the online condition may not have been as attentive as those in the in-person condition. Despite implementing numerous checks for distractions, as an experimenter, you can never observe the environment within the participant's homes and verify whether they are fully engaged in the task. In the in-person condition, distractions are minimized, and the experimenter is present to perceive and manage potential distractions in the room. Another potential explanation could be that the participants in the in-person condition may have felt more pressure due to the physical presence of the experimenter, whereas in the online conditions the participant only interacts with the experimenter's voice, as the camera was turned off during the task. It might be possible that cognitive processes in general work differently in an at-home setting compared to a laboratory setting. As a laboratory environment can influence memory tasks differently than a more viable at-home setting.

Adding on to the differences between the online condition and the in-person condition, the excluded participants might indicate that the participants in the online condition encountered more difficulty in performing the task. This suggestion is supported by the need to exclude five participants from the online condition due to the high scores on the *Compliance Questionnaire*, compared to only one participant form the in-person condition. In total, ten participants were excluded from the online condition sample, while only five were excluded in the in-person condition. As more participants were excluded from the online

condition, this might indicate a possibility that conducting the experiment was more challenging in the online setting than in the in-person setting.

Positive Control-Effect

A positive finding is that a positive control-effect was observed in both experimental conditions, just like the study of Wiechert et al. (2023). Thus, support has been found that active learning causes the participants to better recall the targets in the Think condition than in the baseline condition. The positive control effect highlights the ability to retrieve memories in an active way. The results suggest that participants can consciously and actively recall memories, indicating an effective functioning of memory during the task. It implies that participants are better at retaining information when they engage in active recall, even while in the meantime doing a suppression task. This finding emphasises the importance of active learning strategies.

SIF-Effect and Resilience

For the last hypothesis a positive relationship between resilience, as measured by RES, and the SIF-effect was expected. Contrary to expectations, the current study did not provide support for this relationship. Despite the potential relationship between cognitive processes and resilience, established by Parson et al. (2016), this association was not clearly shown during the TNT-task. A potential explanation could be the complexity of the relationship between cognitive flexibility, resilience and SIF. While the model of Parson et al. (2016) suggests that individuals higher in resilience should show a greater cognitive flexibility, the absence of a significant relationship between resilience and SIF may indicate that other factors are affecting the results. Although cognitive flexibility is a key component of resilience, other factors such as emotional regulation, coping mechanisms, and individual stress responses may also influence the ability to suppress unwanted memories. Another possible explanation for the result could be the complexity of the TNT-itself. While the task

measures cognitive flexibility, it is possible that other aspects of cognitive control and memory processes play a greater role in suppressing memories than just cognitive flexibility. Which could explain why a direct relationship between resilience and SIF was not observed.

Additionally, the limited scope of the *Resilience Evaluation Scale* (Van Der Meer et al., 2018; RES) may have contributed to the lack of a significant finding. With only 9 items, the RES may not fully capture the multidimensional nature of resilience. While the validity of the RES was justified by Van Der Meer et al. (2018), a more comprehensive measure might have captured resilience more effectively. An alternative measure, such as *The Connor-Davidson Resilience Scale* (Connor & Davidson, 2003; CD-RISC), with its 25 items, could offer a more detailed interpretation. With its greater coverage of resilience aspects, the CD-RISC could provide a more holistic understanding of the relationship between resilience and memory suppression. Moreover, its increased number of items could enhance the statistical power of the study, making it more sensitive to subtle associations. Therefore, using a more elaborate questionnaire like the CD-RISC is recommended for future studies to operationalize resilience effectively.

Understanding the role of resilience in cognitive functioning is not just important for memory, but also important for how people cope with difficult experiences in general. By clarifying the relationship between resilience and cognitive processes like memory suppression, future research can guide the creation of new interventions to improve psychological resilience and reduce the impact of intrusive memories.

Limitations

A limitation of the study is its sample. The sample consists of only first year's bachelor students at the University of Groningen, which does not make the results generalizable to a bigger population. This limitation reduced the external validity of the study, thereby restricting the ability to extend the results to other populations or contexts beyond this

specific group. The gender distribution of the sample was unbalanced, with 24 males (26.7%) compared to 63 females (70.0%) which also does not make it generalizable to the whole population. The selection procedure may have introduced bias to the study, as participants were required to sign up voluntarily. The process of self-selection might have attracted individuals with certain characteristics or motivations, potentially leading to an unbalanced sample. As a result, the findings may not accurately reflect the population used in the study, limiting the generalizability of the study.

Another limitation of the study was the early extraction of the data, before the sample goal of $N = 108$ was achieved. Only $N = 90$ participants were taken into the analysis, resulting in reduced statistical power and an increased risk of false negatives (type II error). This implies that the test results might incorrectly suggest the absence of an effect (i.e., the null hypothesis is not rejected), when in the effect might actually exist (i.e., the alternative hypothesis is true). Additionally, due to the early extraction of the data, there is an imbalanced distribution of participants between the online ($N = 41$) and in-person ($N = 49$) conditions. This difference between the conditions is also caused by the exclusion of more participants in the online condition than in the in-person condition, further weakening the statistical power of the online condition and thereby increasing the likelihood of false negatives.

Implications

Although the current study did not directly compare SIF between the in-person and online condition, there does seem to be a discrepancy between suppression-induced in both conditions. The fact that the effect was not statistically significant in the online condition, does not necessarily mean that there is no relationship at all. It may be possible that the online implementation of the TNT-task lacks sensitivity or can encounter methodological challenges that hinder the detection of the effect. Some methodological challenges could be the different environment, possible distractions and a different level of engagement compared to an in-

person setting. If there is a way to elicit the SIF-effect in an online-setting, this could show a possibility to implement interventions remotely, thereby enhancing accessibility for patients. A possible intervention when using the SIF-methodology could be the use of the imaginary exposure. In imaginary exposure the individual needs to retrieve and activate a memory into the conscious mind. While the memory is activated the individual would need to be instructed to try and suppress the memory and try to push it out of the conscious mind. After the memory suppression, the recall of the memory needs to be measured to evaluate if the suppression led to a diminished recall of the memory. In an online setting this could be done by for example sending detailed instructions of the exercise via email or a mobile application. The imaginary exposure could be instructed by using a video- or audio-recording. It could also be done live using Google Meet or Zoom. An example of implementing it remotely could be for individuals dealing with distressing or intrusive memories. If there is a possibility to induce the SIF-effect remotely, this would increase the accessibility of treatment and would make it more flexible and convenient. Despite these suggestions, it is important to note that this study is limited by its specific sample, highlighting the need for further research into SIF, particularly to investigate if it can also be induced remotely.

Even though the current study did not yield a significant finding regarding the relationship between resilience and SIF, further investigation into the relationship between resilience and memory suppression could still offer insights into possible psychological interventions. For this reason, it is suggested to enhance the measurement of the construct of resilience by for example using the CD-RISC. Understanding if resilient individuals are better at suppressing unwanted memories, may inform the development of cognitive interventions aimed at enhancing resilience. By identifying certain cognitive mechanisms underlying resilience, interventions could provide individuals with effective strategies to cope with distressing experiences and promote overall well-being.

Future research should focus on why the SIF-effect presented in the in-person condition but not in the online condition. This is suggested to further gain insight into the mechanisms involved in memory suppression especially in different contexts. It could offer insight into how environmental factors could influence the effectivity of cognitive processes, such as suppressing unwanted memories. Another replication might be useful with some supplementary questions looking into the pressure the participants might have felt by the experimenter, as this might have influenced the results. Future research could also look at the relationship between SIF and resilience by using a more elaborative questionnaire such as the CD-RISC and look into possible interventions that combine resilience with cognitive processes.

Conclusion

Taken together, these results provide support for a suppression-induced forgetting in an in-person setting, but not in an online setting. The results provide support for a positive control effect in an in-person and online setting. The results do not provide support for a significant relationship between resilience and the SIF-effect. However, due to the limited sample and early extraction of data the results of this study are not fully generalizable to a broader population. Future research should focus on why the SIF-effect does not maintain in the online condition and if there is a possible relationship between SIF and resilience using a more elaborate questionnaire.

References

American Psychological Association. (n.d.). *Resilience*. https://www.apa.org. Retrieved December 22, 2023, from https://www.apa.org/topics/resilience

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., & Hulbert, J. C. (2021). Active forgetting: adaptation of memory by prefrontal control. *Annual Review of Psychology*, *72*(1), 1–36. https://doi.org/10.1146/annurev-psych-072720-094140

Anderson, M. C., Ochsner, K. N., Kuhl, B. A., Cooper, J. C., Robertson, E. R., Gabrieli, S., 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

AnyDesk. (2022, October 15). *AnyDesk: the Fast remote desktop application*. https://anydesk.com/nl

Chen, S., Mao, X., & Wu, Y. (2022). Can't Stop Thinking: The role of cognitive control in suppression-induced forgetting. *Neuropsychologia*, *172*, 108274. https://doi.org/10.1016/j.neuropsychologia.2022.108274

Connor, K. M., & Davidson, J. (2003, September 2). *Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC)*. Depression and Anxiety. https://doi.org/10.1002/da.10113

Detre, G., Natarajan, A., Gershman, S. J., & Norman, K. A. (2013). Moderate levels of activation lead to forgetting in the think/no-think paradigm. *Neuropsychologia*, *51*(12), 2371–2388. https://doi.org/10.1016/j.neuropsychologia.2013.02.017

Dieler, A. C., Plichta, M. M., Dresler, T., & Fallgatter, A. J. (2010). Suppression of emotional words in the Think/No-Think paradigm investigated with functional near-infrared

spectroscopy. *International Journal of Psychophysiology*, *78*(2), 129–135. https://doi.org/10.1016/j.ijpsycho.2010.06.358

Dolezal, M. (2021). Predicting First Responder Resilience: Investigating the Indirect Effect of Posttraumatic Cognitions through Coping Processes [PhD, Seattle Pacific University]. In *Seattle Pacific University*. https://digitalcommons.spu.edu/cgi/viewcontent.cgi?article=1066&context=cpy_etd

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/brm.41.4.1149

Google. (n.d.). *Google Meet: Online web and video conferencing calls | Google Workspace*. Google Workspace. https://meet.google.com/

Hertel, P. T., Large, D., Stück, E. D., & Levy, A. J. (2012). Suppression-induced forgetting on a free-association test. *Memory*, *20*(2), 100–109. https://doi.org/10.1080/09658211.2011.647036

Hulbert, J. C., & Anderson, M. C. (2018). What doesn't kill you makes you stronger: Psychological trauma and its relationship to enhanced memory control. *Journal of Experimental Psychology: General*, *147*(12), 1931–1949. https://doi.org/10.1037/xge0000461

Joormann, J., Hertel, P. T., Brozovich, F. A., & Gotlib, I. H. (2005). Remembering the good, forgetting the bad: intentional forgetting of emotional material in depression. *Journal of Abnormal Psychology*, *114*(4), 640–648. https://doi.org/10.1037/0021-843x.114.4.640

Lemhöfer, K., & Broersma, M. (2011). 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

Millisecond. (2022). *Inquisit* (6.6.1) [Software]. https://www.millisecond.com

Parsons, S., Kruijt, A., & Fox, E. (2016). A cognitive model of psychological resilience. *Journal of Experimental Psychopathology*, *7*(3), 296–310. https://doi.org/10.5127/jep.053415

Qualtrics XM - Experience Management Software. (2024, February 28). Qualtrics. https://www.qualtrics.com/

Van Der Meer, C. a. I., Brake, H. T., Van Der Aa, N., Dashtgard, P., Bakker, A., & Olff, M. (2018). Assessing Psychological resilience: Development and psychometric properties of the English and Dutch version of the Resilience Evaluation Scale (RES). *Frontiers in Psychiatry*, *9*. https://doi.org/10.3389/fpsyt.2018.00169

Wagnild, G., & Young, H. M. (1993). Development and psychometric evaluation of the Resilience Scale. *PubMed*, *1*(2), 165–178. https://pubmed.ncbi.nlm.nih.gov/7850498

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

Wiechert, S., Loewy, L. H. S., 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

Wu, R. J. (2023). *Preventative Mental Health Care Programs for Post-Traumatic Stress Disorder* [PhD, Azusa Pacific University]. https://media.proquest.com/media/hms/PFT/2/aGLAR?_s=jO68AgEg1W%2BP6DSD3%2F8QIyNtw28%3D

Appendix A

Resilience Evaluation Scale

This appendix contains the Resilience Evaluation Scale as it was presented in Qualtrics.

The next nine questions are about resilience. Resilience is defined as the capacity to recover quickly from difficulties. It is a process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional and behavioural flexibility. Please select the most accurate answer for yourself at each statement.

	Completely disagree	Disagree	Neutral	Agree	Completely agree
I have confidence in myself	○	○	○	○	○
I can easily adjust in a difficult situation	○	○	○	○	○
I am able to persevere	○	○	○	○	○
After setbacks, I can easily pick up where I left off	○	○	○	○	○
I am resilient	○	○	○	○	○
I can cope well with unexpected problems	○	○	○	○	○
I appreciate myself	○	○	○	○	○
I can handle a lot at the same time	○	○	○	○	○
I believe in myself	○	○	○	○	○

Appendix B

This appendix contains visualisation of the assumptions of normality checks for the paired-samples t-tests in the *Results* section.

Figure B1

Histogram of the SIF-effect in the In-Person Condition

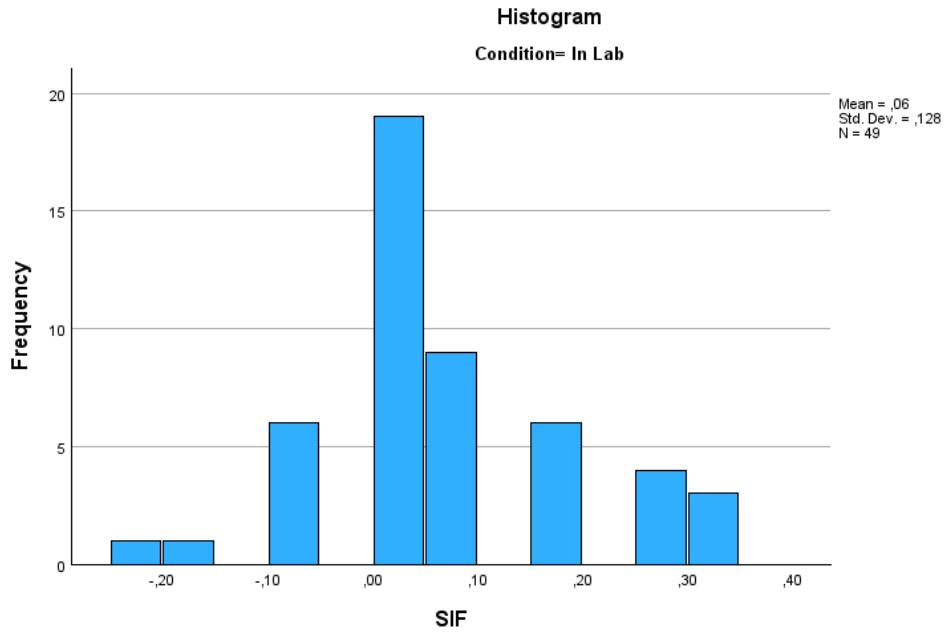


Figure B2

Q-Q Plot of the SIF-effect in the In-Person Condition

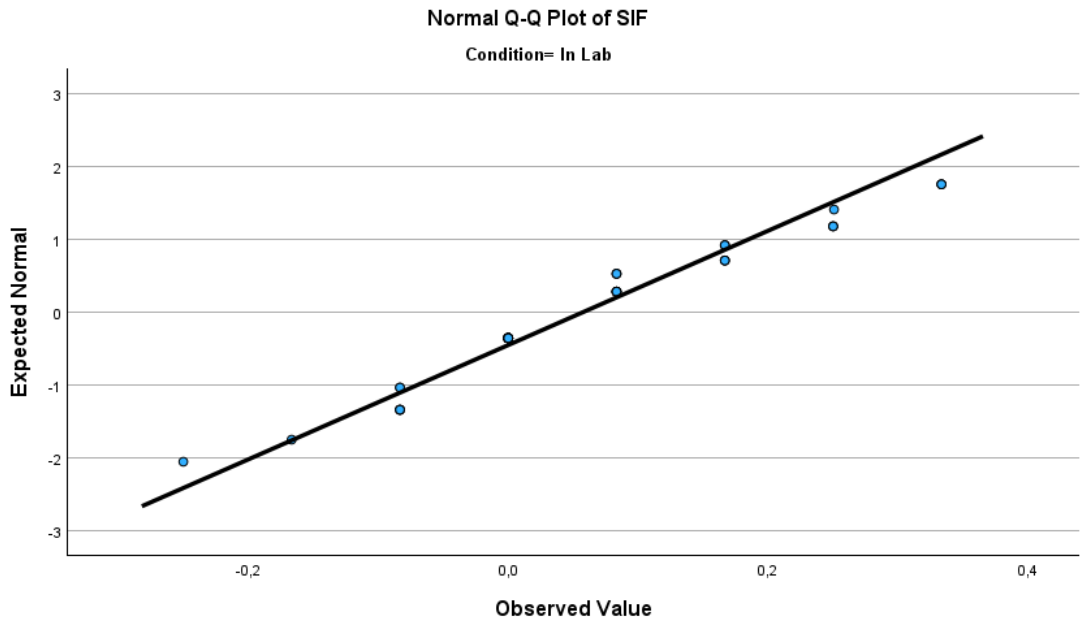


Figure B3

Histogram of the SIF-Effect in the Online Condition

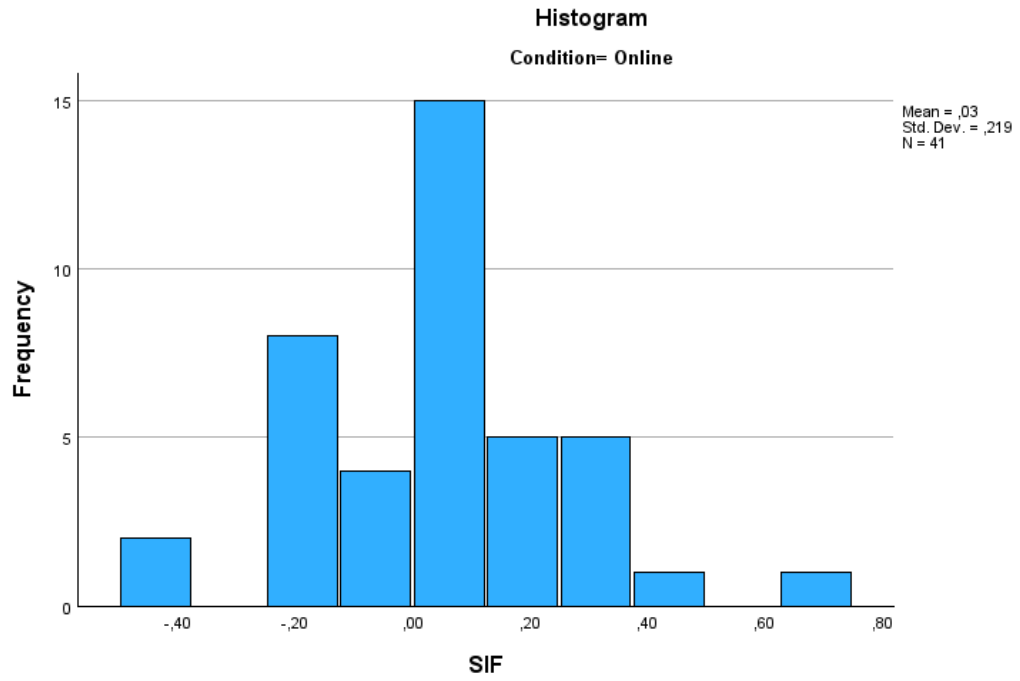


Figure B4

Q-Q Plot of the SIF-Effect in the Online Condition

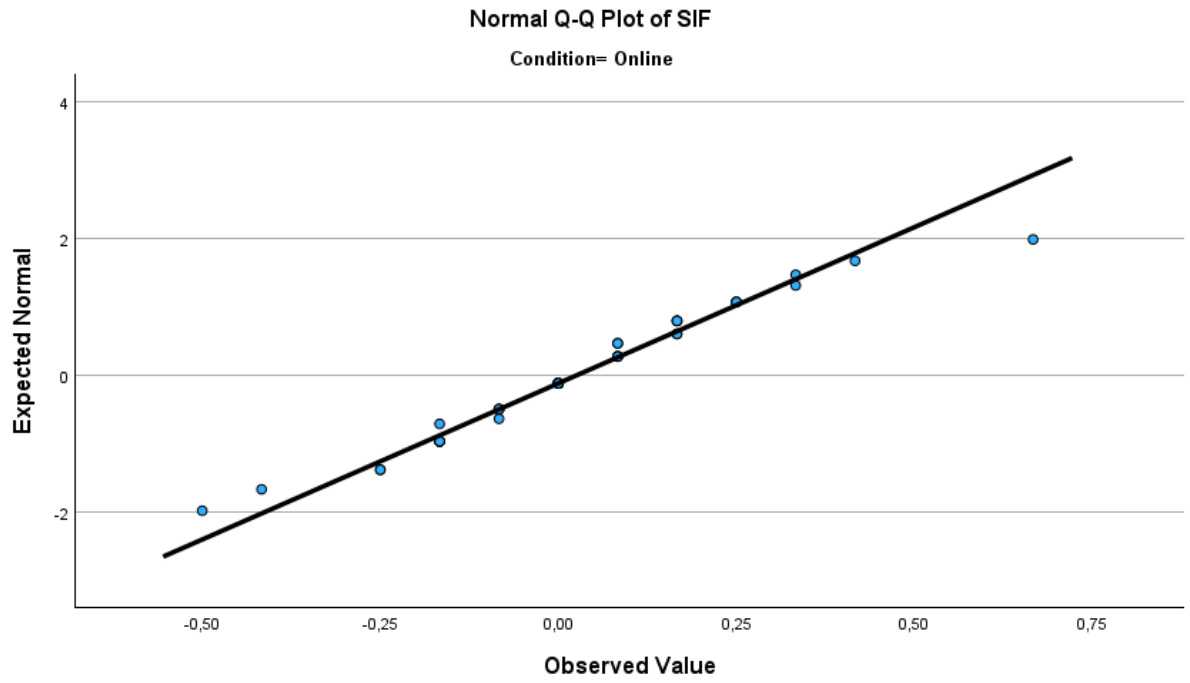


Figure B5

Histogram of the Positive-Control Effect in the In-Person Condition

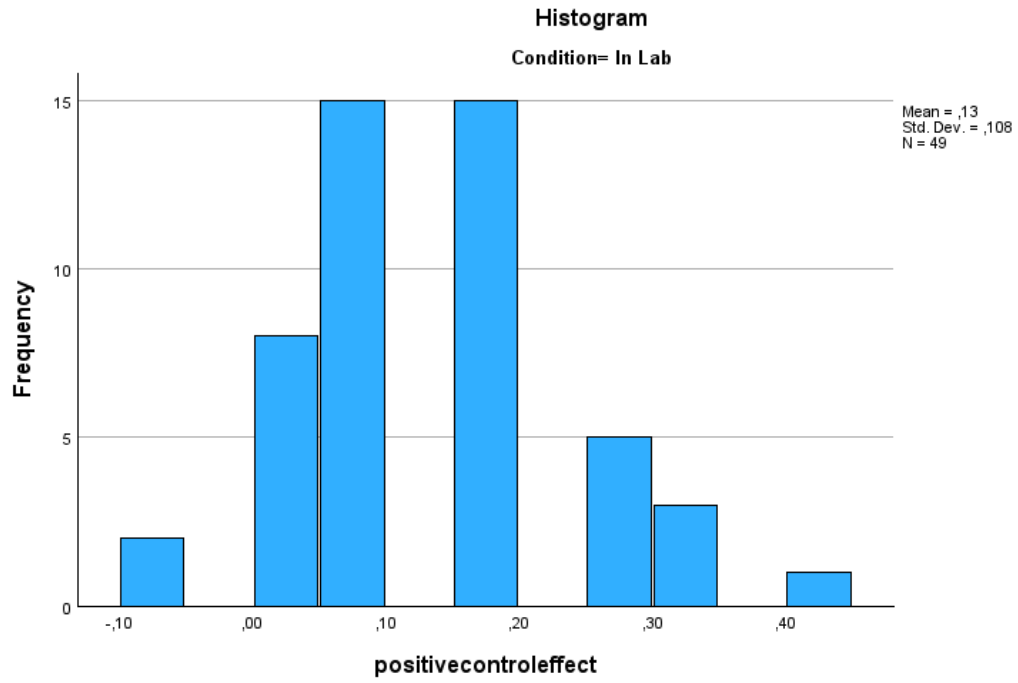


Figure B6

QQ-plot of the Positive-Control Effect in the In-Person Condition

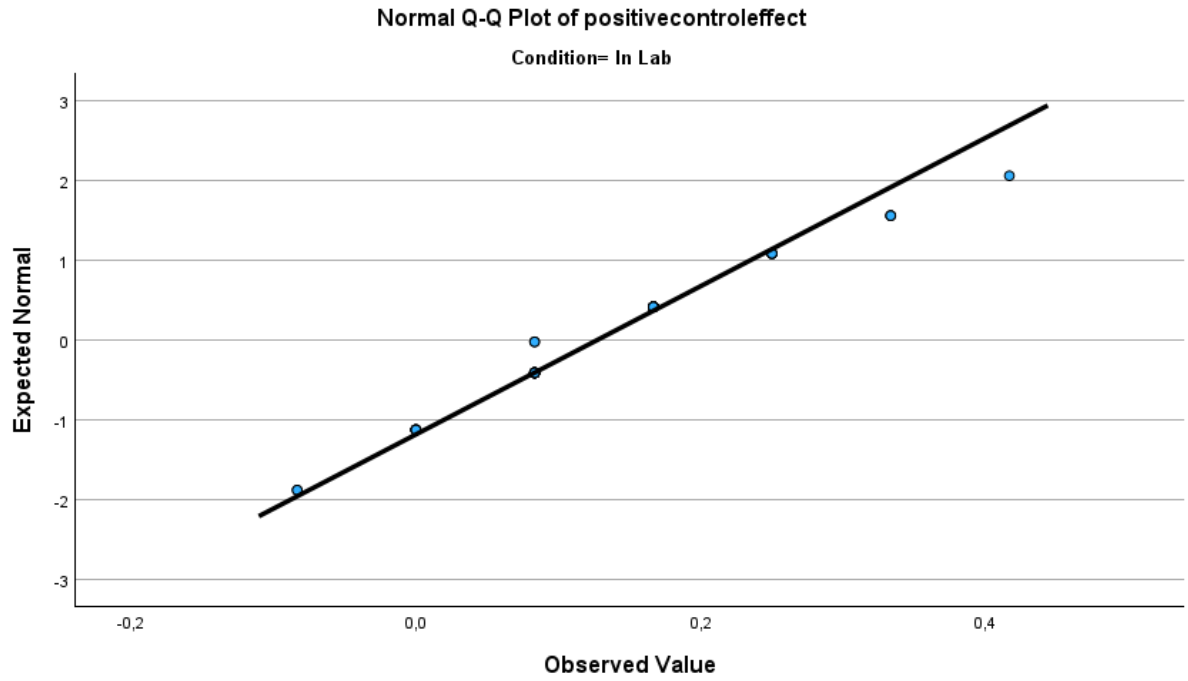


Figure B7

Histogram of the Positive-Control Effect in the Online Condition

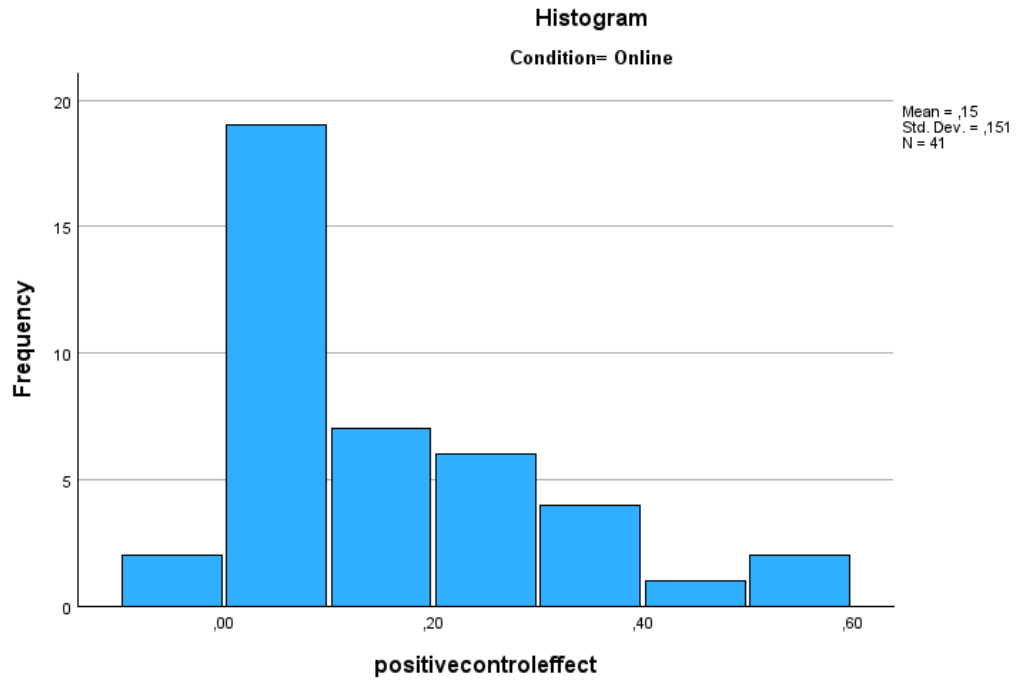
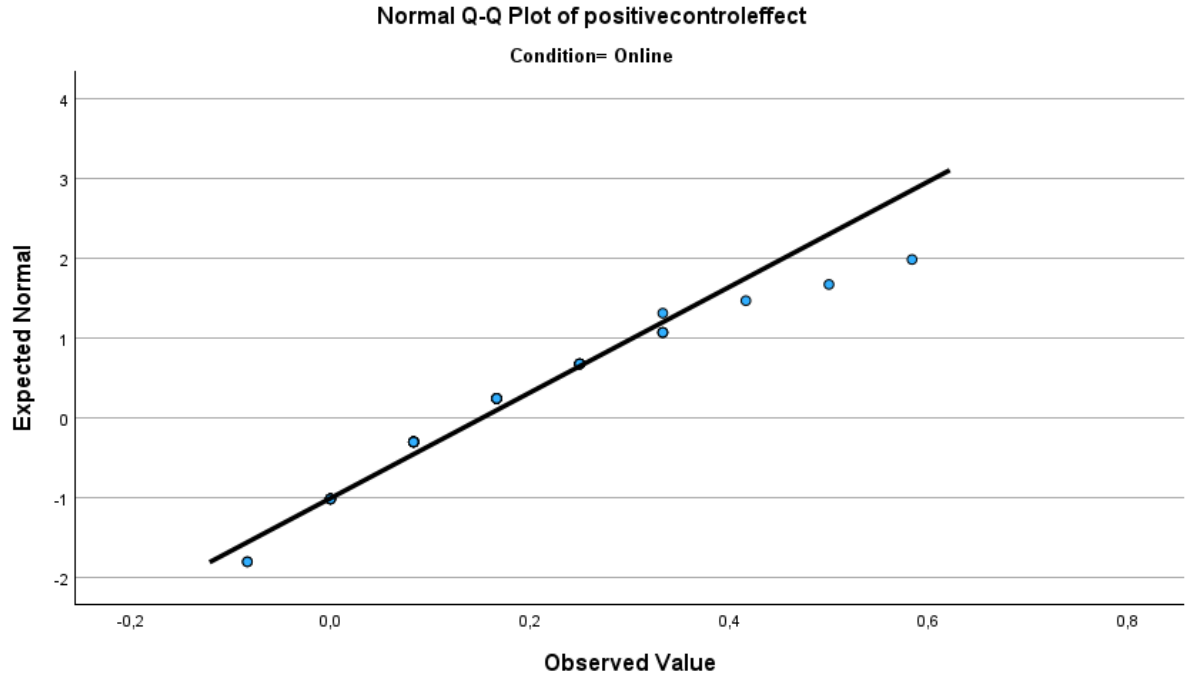


Figure B8

QQ-Plot of the Positive-Control Effect in the Online Condition



Appendix C

This Appendix contains statistical results of the paired-samples t-test and visualisations of the correlations that are part of the *Results* section.

Table C1

Paired Samples Statistics[a] of the SIF-Effect

		Mean	N	Std. Deviation
Pair 1	propCorrect_Phase3_Suppression	,80440816333	49	,148865575550
	propCorrect_Phase3_Baseline	,86224489796	49	,105616329964

a. Condition = In Lab

Table C2

Paired Samples Statistics[a] of the SIF-Effect

		Mean	N	Std. Deviation
Pair 1	propCorrect_Phase3_Suppression	,80284552851	41	,175550817230
	propCorrect_Phase3_Baseline	,82926829276	41	,152469509149

a. Condition = Online

Table C3

Paired Samples Statistics[a] of the Positive-Control Effect

		Mean	N	Std. Deviation
Pair 1	propCorrect_Phase3_Recall	,98979591841	49	,027600054936
	propCorrect_Phase3_Baseline	,86224489796	49	,105616329964

a. Condition = In Lab

Table C4

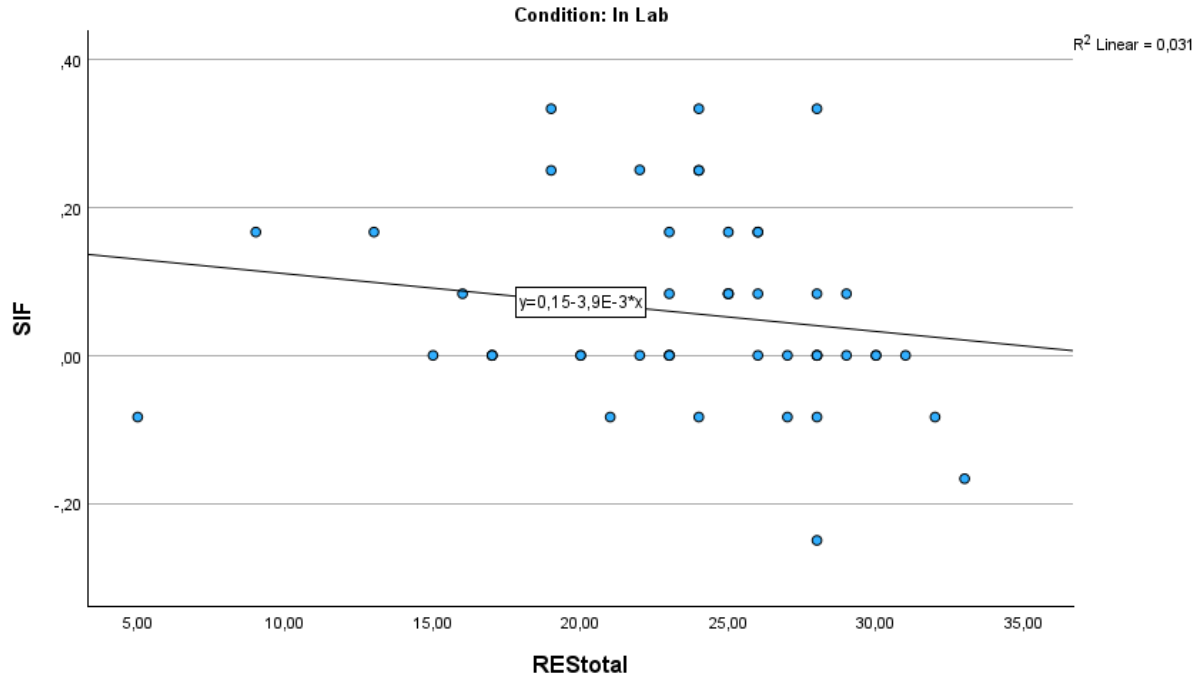
Paired Samples Statistics[a] of the Positive-Control Effect

		Mean	N	Std. Deviation
Pair 1	propCorrect_Phase3_Recall	,98170731710	41	,051072508086
	propCorrect_Phase3_Baseline	,82926829276	41	,152469509149

a. Condition = Online

Figure C1

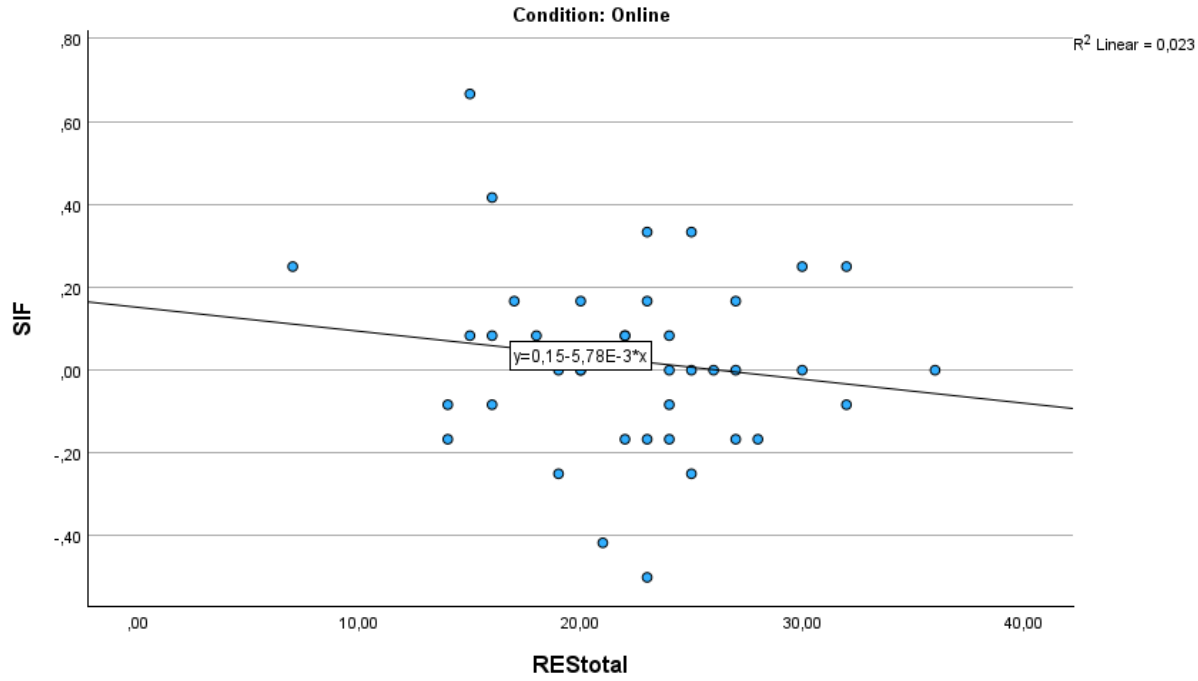
Scatterplot Resembling the Relationship between Resilience and SIF in the In-Person Condition



Note: variable REStotal resembles resilience.

Figure C2

Scatterplot Resembling the Relationship Between Resilience and SIF in the Online Condition



Note: variable REStotal resembles resilience.