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Cognitive Resilience in Trauma: Exploring the
Impact of Mood and Tetris on Intrusion
Development

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Abstract

Many people will experience a traumatic event during their lifetime which can lead to the experience of involuntary memories (intrusions). Several factors can influence the development of intrusions, including the mood one experiences during a traumatic experience. This study aimed to investigate whether present mood is associated with the frequency of intrusions after watching a trauma film. Furthermore, prior research suggests that performing a working memory task (Tetris) could decrease intrusion frequency due to the reallocation of cognitive resources from processing the event to performing the task. Thus, it was tested if the association between emotion and intrusion frequency would be influenced by performing Tetris after watching a trauma film. It was hypothesized that negative emotions would increase after watching a trauma film compared to before. Furthermore, it was hypothesized that there would be positive correlations between mood change and intrusion frequency measured in a diary and scores on the IMS intrusion subscale. Finally, it was hypothesized that there would be a difference between the Tetris condition and a control condition regarding the associations between mood change and the intrusion-based variables. To investigate this, the trauma film paradigm was used in a sample of undergraduates ($n=153$). A paired samples t-test revealed a statistically significant increase in negative mood after watching a trauma film. Spearman's rank correlations showed a weak, statistically significant positive correlation between mood change and image-based diary intrusions and a weak, statistically significant positive correlation between mood change and IMS intrusions. Finally, Fisher's Z-test was used to test whether there was a significant difference between conditions regarding the association between mood change and diary intrusions and IMS scores. The correlation between mood change and image-based diary intrusions yielded a negative outcome, indicating that the strength of correlations is similar between conditions. The correlation between mood change and IMS scores yielded a statistically significant positive

outcome, meaning the correlation is more robust in the Tetris condition compared to the control condition. The results indicate that emotions are likely a factor that does not substantially contribute to intrusion development and intrusion development is at least partly moderated by playing Tetris. Together, these findings contradict prior research regarding the influence of emotion and the effect playing Tetris has on intrusion development.

Keywords: trauma film paradigm, working memory task, Tetris, mood change, intrusion

“Cognitive Resilience in Trauma: Exploring the Impact of Mood and Tetris on Intrusion Development”

When we think of traumatic events, we often imagine grand tragedies, such as wars and natural disasters. However, trauma often stems from more common events.

Approximately 80 % of people will experience a traumatic event in their lifetime (Birur et al., 2016). A traumatic event is defined by the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as “exposure to actual or threatened death, serious injury, or sexual violence (...)” (American Psychiatric Association, 2013, p.271). Post-traumatic stress disorder (PTSD) is the most prevalent disorder associated with experiencing a traumatic event.

The hallmark symptom of PTSD is intrusions, more commonly known as “flashbacks”. According to the DSM-5 Criterion B requires the existence of at least 1 out of possible 5 intrusion symptoms. The symptoms can range from experiencing involuntary memories or recurrent dreams of the event to the famed “flashbacks” in which a person feels they are re-experiencing the traumatic event (American Psychiatric Association, 2013). Intrusions can appear outside of psychopathology and clinical populations as well. They are described as an involuntary memory that can involve any or all of the five senses and usually appear as a mental image or verbal thought. For example, many people have had sudden memories of an embarrassing moment from their past. It could be an awkward social interaction, a public speaking mishap, or a moment of clumsiness. This memory might be accompanied by feelings of embarrassment, discomfort, or even a physical reaction like blushing or a racing heartbeat.

Even though a large part of the population will experience a traumatic event only a small part of the population will go on to develop PTSD or other trauma-related symptoms (Birur et al., 2016). Thus, it is important to gain an understanding of the factors contributing

to intrusion development which would further understanding of trauma-related disorders and might give new insights into treatment options for them. Multiple factors may influence the development of intrusions.

Trauma film paradigm

One foundational concept in this research area is the trauma film paradigm (TFP). The TFP is an experimental tool that is analogous to a traumatic event. By employing this paradigm, intrusions can be reliably induced in a laboratory setting, adhering to the principles of control and replicability in scientific research, and the association between traumatic events and intrusion development/frequency can be studied (Holmes & Bourne, 2008). It involves showing participants a film that simulates a traumatic experience, allowing for a wide range of traumatic events to be induced, including depictions of natural disasters, interpersonal violence, and accidents. Without the TFP one would largely rely on retrospective studies, limiting the ability to establish causal relationships. Additionally, traumatized individuals may differ systemically from non-traumatized individuals. However, by using this paradigm it becomes possible to control for potential differences and other influential factors, making research consistent and replicable. Thus, it contributes to understanding trauma-related reactions and adds to the development of interventions and treatments for PTSD and intrusions.

Emotional and other psychological factors influencing intrusion development

One factor influencing intrusion frequency could be the change in mood a person experiences during a traumatic event. Clark et al. (2014) conducted a meta-analysis of individual participant data from 16 studies investigating the association between emotional response to a trauma film and the absence of intrusions. They found that a low emotional response regardless of the type of emotion (fear or depression) was associated with the absence of intrusions. This suggests that diminishing the emotional response at the time the

traumatic event takes place could be beneficial in reducing the amount of intrusions and could potentially have a protective effect. It is possible that decreasing the number of intrusions could also have an influence on the development of psychopathological responses (i.e. developing PTSD or other trauma-related disorders). To date, this is the only research examining the link between emotional responses and traumatic experiences.

Another study investigated the relationship between intrusion frequency and emotional and personality factors (Laposa & Alden, 2006). Their results suggest that trait anxiety, depression, and trait dissociation were associated with the frequency of intrusions. It could be that possessing these traits may predispose individuals to experience a heightened emotional response when experiencing a traumatic event. Furthermore, they found that post-state anxiety had a mediating effect on the relationship between intrusion frequency and trait anxiety, depression, and trait dissociation. This means that the effect of trait anxiety, depression, and dissociation could be partly explained by the emotions that arise shortly after having a traumatic experience. Thus, it appears that emotional experience during the event of a traumatic experience could influence the development of intrusions. Moreover, it could be that decreasing the intensity of emotions after a traumatic experience could help to decrease the development of intrusions and possibly PTSD symptoms. The existing research is primarily focused on the relationship of trait anxiety and depression, as well as fearful and depressive emotional reactions and the occurrence of intrusions. However, there is a lack of direct randomized controlled trials exploring the link between emotional reactions (i.e., mood change) and intrusion frequency.

Tetris as Working Memory task

A potential way of preventing or reducing the development of intrusions may be performing tasks that engage the visual Working Memory (WM). In a study individuals with different types of traumas were asked to describe the quality and content of intrusions they

experienced. Ehlers et al. (2002) found that the most common intrusions were of visual kind across all kinds of trauma. Thus, choosing a WM task that engages visual resources could possibly lead to the most amount of interference in developing intrusions. Currently, there is a discussion about whether performing a WM task, namely playing the game Tetris, helps in reducing the frequency of intrusions following the experience of a traumatic event. Playing Tetris involves mentally rotating blocks and anticipating which position is best for the block currently in play. Additionally, there is a preview of the next block that will come into play. The original research comes from Holmes et al. (2009) who claim that playing Tetris can reduce the frequency of intrusions and act preventatively as a “cognitive vaccine” after watching a trauma film. Their rationale behind this intervention is that playing Tetris takes up cognitive resources in the WM that may interfere with the development of intrusions. More specifically, it is hypothesized to take up visual-spatial resources in the WM. However, there is no direct way to assess whether Tetris actually taxes the visuo-spatial WM.

Research supporting Tetris

In general, there is some research supporting the rationale that using cognitive tasks burdens the visuo-spatial WM. Deerprouse et al. (2012) showed a reduction in intrusions when participants performed a visuo-spatial tapping task vs two control conditions (verbal task and no task). As mentioned before, Holmes et al. (2009) proposed that playing Tetris might act as a “cognitive vaccine” against developing intrusions. Since their original study, there have been attempts to replicate these findings. The majority of this research supports the effectiveness of playing Tetris.

Holmes et al. (2010) conducted another study using the same rationale but using a Pub quiz as a comparison condition to Tetris, which yielded similar results to the original study. Additionally, they found that even when increasing the time between watching a trauma film and playing Tetris the beneficial effects can still be retained. In a replication study of the

aforementioned research, Badawi et al. (2020) found that performing a cognitive task may reduce the experience of intrusions. Compared to another cognitive task taxing the visuo-spatial WM (D-Corsi intervention, a digital version of the traditional Corsi block tapping task) and a no-task control condition, playing Tetris proved to be superior in reducing intrusions after watching a trauma film. Badawi et al. (2020) suggested that the D-Corsi task did not tax the visuo-spatial WM that is involved in memory encoding. Furthermore, they claimed that this might be due to the more complex task of previewing the falling blocks in Tetris and mentally rotating them, while the D-Corsi task is about storing and then remembering a sequential pattern. This would make Tetris a more complex task, thus possibly taxing the visuo-spatial WM more. It is important to note that the Badawi et al. (2020) study is the only independent (from the original authors) replication study that yielded significant reductions and was pre-registered, thereby limiting publication bias and probability of false positive results (Wessel et al., 2021).

Furthermore, there is some support for this intervention coming from real-life studies. Iyadurai et al. (2017) found support for the Tetris intervention in a real-life setting, where participants were asked to play Tetris at an emergency department after being in a car accident. They found a decrease in intrusion frequency in the Tetris condition compared to a no-task control condition. Additionally, Horsch et al. (2017) found a decrease in intrusions in a similar study involving playing Tetris versus a no-task control with women who had an emergency cesarean section. It is important to note that the sample sizes in both of these studies were rather small (37 and 29, respectively) and neither of these studies were preregistered (Wessel et al., 2021).

Another study explored whether Tetris had any effects on intrusion reduction if it was played before watching a trauma film. Yet, no evidence for a preventative effect was shown (James et al., 2016).

Some were inspired to extend the research beyond playing Tetris on a computer desktop. In one study using the TFP, it was shown that playing Tetris in Virtual reality led to significantly fewer intrusions compared to playing Tetris on a desktop or a no-task control (Page & Coxon, 2017). Again, it is important to note that this study included a rather small sample (n=10) but they were the only study able to show a significant reduction in intrusions and are independent of the original researchers.

Research opposing Tetris

Even though the majority of research sounds promising besides some obvious limitations there is some research opposing the notion that playing Tetris decreases the frequency of intrusions. Asselbergs et al. (2018) developed an app based on the Tetris studies that is similar to playing Tetris and taxed visuo-spatial WM. They were unable to find a significant reduction in intrusions. Similarly, Hagenars et al. (2017) tested whether Tetris compared to a Word game and a no-task control led to fewer intrusions 4 days after watching a trauma film and performing a reactivation task before. While Tetris led to fewer intrusions than the control condition there is some weak evidence that the word game led to even fewer intrusions.

The current study

Tetris seems to be a promising intervention. It would be a cost-effective, uncomplicated, and easily accessible intervention that can quickly be deployed to people that have recently experienced a traumatic event. Until now there is a lack of independent research following scientific research principles (i.e., preregistering research) with samples big enough to detect a reliable effect and generalizable results. Subsequently, it is not possible to establish a robust preventative effect of the Tetris intervention. Additionally, there have been no longitudinal studies because most research uses a week-long diary for the recording of intrusions with no follow-up after. The emotional and cognitive processing of traumatic

experiences remains a complex field that needs further research. Additional empirical evidence is required to unravel the underlying mechanisms and better understand the various factors that may influence this process. Furthermore, there is an ongoing discussion about the definition, diagnosis, and etiology of PTSD, influential factors, and best course of treatment. Concurrently, opinions differ across disciplines, highlighting the complexity of the issue that necessitates the integration of multiple approaches and models (for an overview see: Miao et al. (2018)). Given that intrusions are a defining characteristic of PTSD and are frequently linked to significant distress, it is logical to explore strategies aimed at reducing the frequency of intrusions or impeding their development.

Although it seems that there is an association between the emotional reaction to a traumatic experience and the frequency of intrusions, there is a gap in the literature to establish a relationship. Therefore, the current study aims to investigate whether present mood is a psychological variable that is associated with the frequency of intrusions after watching a trauma film and if this association would be influenced by performing Tetris after watching a trauma film. It is hypothesized that (1) negative mood will increase after watching a trauma film (Holmes & Bourne, 2008). Furthermore, it is hypothesized that (2) there is a correlation between the change in mood and intrusion frequency, meaning that the greater the negative mood the more intrusions should develop (Clark et al., 2014). Finally, it is hypothesized that (3) due to the reallocation of cognitive WM resources when playing Tetris, there is a stronger correlation between mood change and intrusion frequency in the control condition compared to the Tetris condition (Badawi et al., 2020; Holmes et al., 2009; Holmes et al., 2012).

It is predicted that negative mood/emotions increase after watching a trauma film and thus scores on the post-film mood measure will increase across all six subscales compared to the pre-film mood measure in both conditions. Secondly, it is predicted that there are positive correlations between mood change and both intrusion-dependent variables. Finally, it is

predicted that there is a stronger correlation between both outcome variables and mood change in the control condition compared to the experimental condition.

Method

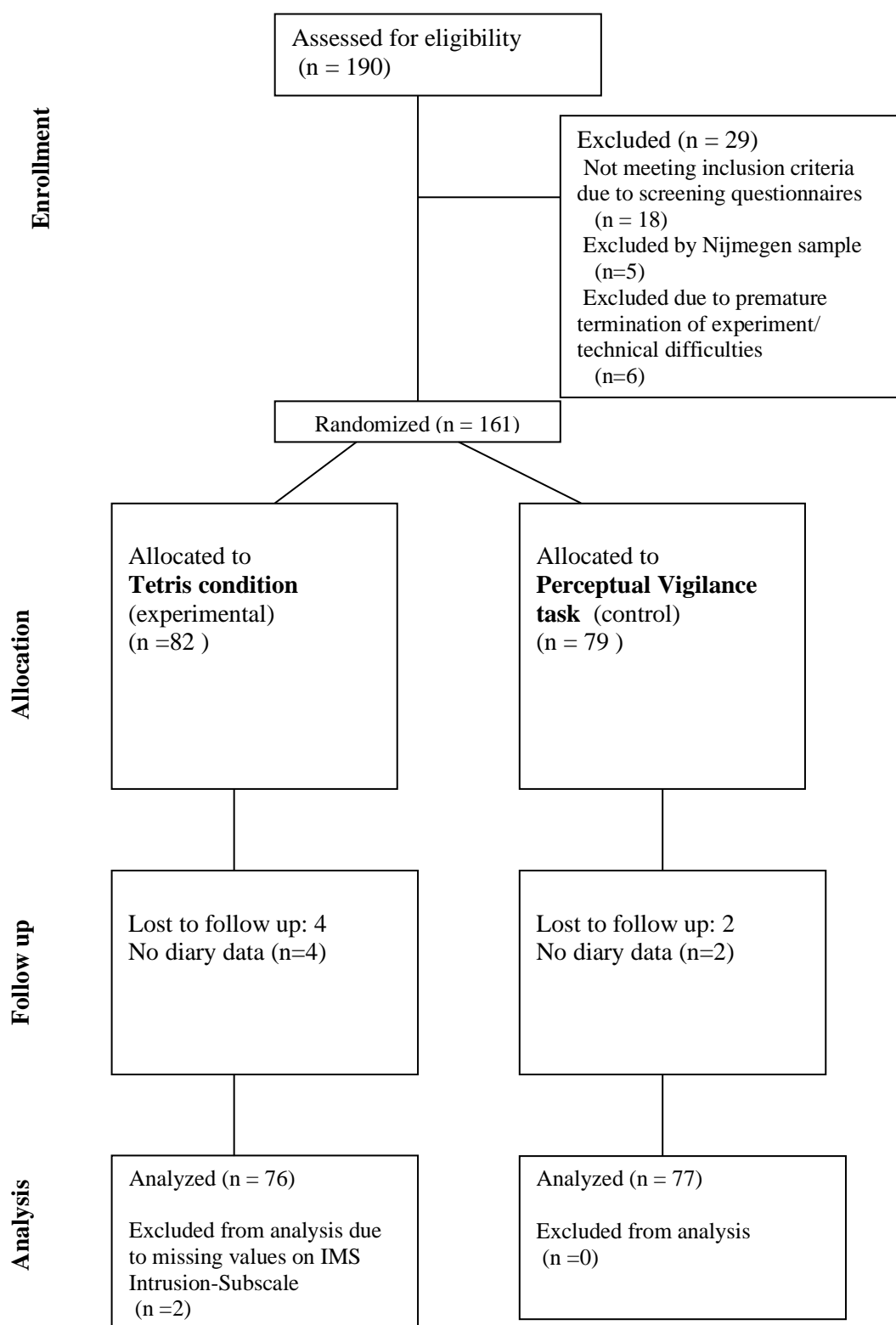
Transparency

The data used was part of a multi-site replication study of the experiment by Holmes et al. (2009) investigating whether playing Tetris is helpful in decreasing the number of intrusions after watching a trauma film (Wessel et al., 2021). This sample included data from the University of Groningen and Radboud University Nijmegen (Netherlands). For more information and a more detailed explanation of the measures and procedure please refer to the preregistration for the aforementioned study (<https://osf.io/hj8ad>).

Participants

A total of 190 undergraduate psychology students participated in the study and in the end, 154 participants provided full data with an age range from 18 to 57 ($M = 21.88$, $SD = 6.77$). Participants were not selected if they exceeded cut-off scores on two screening questionnaires, if they already took part in similar studies to make sure there was no pre-knowledge, or if they did not give consent to take part in the study. Figure 1 illustrates the participant flow, showcasing the progression of participant exclusion throughout the stages of enrollment, allocation, follow-up, and analysis, along with the reasons for exclusion. In total 108 participants identified as female and 46 identified as male or other. The study included participants from 17 different nationalities, with Dutch (51.9%) and German (29.7%) representing the majority of participants. To ensure the adherence to research standards and ethical practice the study outline was submitted to and approved by the Ethics Committee of the Faculty of Behavioral Sciences (EC-BSS) at the University of Groningen.

Figure 1: Participant flowchart



Materials

Most materials across all sessions are presented using Qualtrics (Version November 2021 [computer software]. Provo, Utah, USA: Qualtrics). The trauma film is shown on a separate page, Vimeo player, reached through a private link. Tetris and the perceptual vigilance task are presented using PsyToolkit (Stoet, 2010, 2017; <https://www.psychtoolkit.org/>).

Measures

Screening

Quick Inventory of Depressive Symptomatology (QIDS; Rush et al., 2003). The QIDS is a self-report measure consisting of 16 items that assessed depressive symptoms over the last week and was scored on a 4- point Likert scale ranging from zero (absent) to three (severe). The total score ranges from zero to 27. Participants were excluded if the QIDS indicated the presence of moderate to severe depression (total score ≥ 11). It demonstrates promising validity and reliability as a depression severity scale, but further research is needed to fully establish its psychometric properties (Reilly et al., 2015).

Trauma Screening Questionnaire (TSQ; Brewin et al., 2002). The TSQ is another self-report measure consisting of 10 items indicating if posttraumatic stress reactions have been experienced at least twice over the past week (0= No ; 1 = Yes). The responses are totaled and can range from 0 to 10. Participants were excluded if the TSQ scored above the cut-off score (total score ≥ 6).

Mood measure

The mood measure consisted of 6 separate scales represented as visual analog scales (VAS) on which participants reported the extent to which they feel sad, hopeless, fearful, horrified, anxious, and depressed at the present moment using a slider scale ranging from 0

(not at all) to 100 (extremely). They have been adapted from James et al. (2015). Responses were recorded before and after watching the trauma film.

Intrusion measures

Diary. A diary was used to note any occurrence of an intrusion related to the trauma film watched previously. A table was provided to note whenever an intrusion was experienced in shorthand (using I for sensory / image; T for thought; IT for a combination) in the morning, afternoon and evening, every of the seven days following the second session. It is an adapted version from James et al. (2015). The diary was provided as a Word document that was filled in online or printed and filled in manually.

Impact of Movie scale (IMS; James et al., 2015). The IMS is a 22-item self-report questionnaire measuring possible difficulties participants might experience in the seven days after watching the trauma film on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely). It is an adaptation of the Impact of Event-Scale Revised (IES-R; Weiss & Marmar, 1997).

Experimental checks.

Diary compliance. A set of four statements was used to explore the experience the participants had in the seven days where they had to fill in the diary. The statements “To what extent is the following true: I have been unable (or forgotten) to record my unpleasant thoughts and images in the diary.”, “Please indicate how accurately you think you completed the diary.” and “To what extent did the daily email trigger intrusions of the film?” could be answered using a sliding scale ranging from 0 (not at all true of me) to 100 (extremely true). The participants answer “Do you have any suggestions or comments regarding the diary?” using an open-answer format.

Film ratings. The following 4 questions were presented together with the post-film mood scales. The first 3 questions (“How distressing did you find the film?”, “How much attention

did you pay to the film you just watched?” and “To what extent did you close your eyes or look away during the film you just watched?”) could be answered using a sliding scale ranging from 0 (not at all) to 100 (extremely, total attention, the whole film, respectively). The last question (“What did you use for sound?”) had 4 answer options (1 = *headphones*, 2 = *in-ear plugs*, 3 = *computer sound system*, 4 = *other*).

Other components

Trauma film. The trauma film spanned around 12 minutes and was comprised of 11 distinct scenes that portrayed various scenarios involving blood, injury, explicit physical or sexual violence, and death caused by interpersonal violence, accidents, or natural disasters. This film is an adaptation of the one used by Holmes et al. (2009) and included acted material from commercial movies or advertisements or real-life footage freely accessible on YouTube. The findings of an independent experiment (refer to <https://osf.io/n42he/>) indicated that the film, in comparison to the original film in Holmes et al. (2009), was not significantly different in terms of the number of intrusions reported by participants in a seven-day diary.

Manipulation. Participants were randomly assigned to either an experimental condition (Tetris gameplay) or a control condition (Perceptual vigilance task). This was done using the Qualtrics randomizer function.

Tetris gameplay. A special research version of this game was used (Tetris Company Inc., 2021). Tetris is a computer game that challenges players to rotate seven differently colored and shaped blocks to form a continuous line. If a line is successfully formed it will fall away and the player gains points. Every ten eliminated lines increase the difficulty level, causing the blocks to fall faster from the top of the screen. Additionally, a preview box shows the next block, allowing players to mentally rotate them and plan ahead. The task lasted 10 minutes.

Perceptual vigilance task. This task is an adaptation of the Perceptual vigilance task (Wilkinson & Houghton, 1982); [http://pebl.sourceforge.net/wiki/index.php/PEBL Perceptual Vigilance Task](http://pebl.sourceforge.net/wiki/index.php/PEBL_Perceptual_Vigilance_Task)). In the task, attention was directed toward a black screen intermittently displaying a red circle. The task comprised 20 trials, each lasting 30 seconds, with a 2-second interval at the beginning and end. The objective was to promptly press the spacebar upon noticing the appearance of the red circle, aiming to respond within 2 seconds to be considered "on time". The task lasted 10 minutes.

Daily reminder email. This email was sent every day at 8 am over the 7 days in which the participant had to fill in the diary and read: "*This is a friendly reminder to please report any intrusions you may experience into your diary today*".

Diary instructions. Information on what counted as an intrusion was provided. Additionally, it was needed to specify whether the intrusion was image- or thought-based, or a combination thereof.

Involuntary memory diary checklist. This checklist consisted of 10 yes/no items which provided a summary of the diary instructions.

Procedure

The participants were recruited online via SONA and received 4 credits if they completed every part going towards their research obligation of the bachelor's program. Participants were made aware of the graphic content in this research and advised to not participate if they felt they were sensitive towards this type of content.

The participants were asked to attend three separate online sessions spanning about 2 hours in total. During the first session (30 minutes), the screening, participants were informed about the content and nature of the study and informed consent was given or denied. If denied, the session was terminated at that point and the participant received credits for only

attending the first part. If consent was given participants provided demographic data, then filled out the QIDS and TSQ and another questionnaire measuring depression, anxiety, and stress to assess eligibility. If the participant was not eligible according to the scores, the session was terminated and the participant received credits for only attending the first part.

If the participant was eligible, the second session (60 minutes) began immediately. First, the participant was asked to practice the game Tetris for 3 minutes. After, they filled out the pre-film mood measure indicating their current mood. Then, the participants were given instructions on how to watch the trauma film, watched it and after that, they were asked to fill in the post-film mood scales and film ratings. Then followed a filler task in which they had to rate classical music according to pleasantness for 10 minutes, and a reminder task where still images from the trauma film were shown. After this, a screen provided instructions to participants to remember a number. Based on the number (8 = perceptual vigilance task, 55 = Tetris) the participants were randomly allocated to the condition (gender was counterbalanced across conditions). In the experimental condition, the participant was instructed to play Tetris again for 10 minutes, and in the control condition, the participant performed a perceptual vigilance task. After they performed the task they were asked to rate how often they already experienced an intrusion during the last task and how difficult they thought the task was. Subsequently, it was explained how to fill in the diary they had to keep for the upcoming week and they had to complete a quick checklist to check their understanding of the instructions. If needed, additional information was given. After the session ended and credits for the first two parts were granted.

During the week the participants had to keep track of their intrusions using the diary and received a reminder email every morning at 8 am to help with this. Exactly a week after the first two sessions took place the participant was expected to return online for session 3 (30 minutes). First, diary compliance is assessed and then follows the IMS measure. After, the

participant was asked to complete a visual-spatial short-term memory task (Corsi block-tapping test) and then finally debriefed and asked to fill out a participation experience questionnaire aimed at improving study conduct. After completing the third session the participant received credits.

Statistical analysis

All statistical analyses were performed using SPSS (Version 28).

Data preparation

Data was anonymized by assigning randomly generated 6-digit identification codes using <https://www.random.org/> and erasing identifying information from the diaries and questionnaires. Demographic information (collection site, age, nationality, gender, and condition) was saved in a different SPSS file than any experimental scores. Following the advice of Julie Pallant (2010) cases with missing information were excluded list-wise from the analysis to preserve statistical power.

The variable mood change was created in two steps. First, a mean score across all six subscales was calculated per participant in the pre-film and post-film mood measures. Second, a difference score between the two measures was calculated by subtracting the pre-film score from the post-film score per participant.

Lastly, the intrusion-based variables “Mean_IMS_Intrusionscale” and “Diary Sum Total_I and Total_IT” were created. All items belonging to the intrusion subscale on the IMS were scored and averaged per individual to receive the “Mean_IMS_Intrusionscale”. Purely image-based intrusions (indicated as “I”) and combinations of thought- and image-based intrusions (indicated as “IT” in the diary) across each diary were added to receive a total sum score of image-based intrusions per individual to receive “Diary Sum Total_I and Total_IT”.

Main analyses

Experimental checks. To investigate whether there would be differences between conditions regarding the experience of the trauma film, the understanding of diary instructions and the completion of the diary means and standard deviations were calculated.

Hypothesis testing.

Mood change. To investigate whether there would be a change in mood after being exposed to a trauma film, a paired-samples t-test with baseline mood score and post-mood score as variables, was run.

Correlations between mood change and intrusion measures. To investigate the degree to which mood change is related to the number of intrusions in both outcome measures (IMS scale and diary intrusions) a correlational analysis was performed using Spearman's rank correlations. Furthermore, effect sizes were calculated using Cohen's d (Cohen, 1988).

Moderator analysis. To investigate whether there was a significant difference of correlations between the conditions Fisher's z-test statistic was calculated using the following website <https://www.psychometrica.de/correlation.html#cohen>.

Exploratory analysis. Exploratory analyses were performed to investigate the different subscales of the mood measure.

Results

Experimental checks

Experience trauma film

Table 1 shows the means and standard deviations for experimental checks regarding the attention the participants paid, the distress they experienced, and the extent to which they closed their eyes while watching the film. Another experimental check regarding the Soundsystem the participant used while watching the film revealed that 78.6% of participants used headphones or in-ear plugs as requested. 20.8% used the computer sound system and 0.6% indicated to have used something different.

Table 1*Experimental Checks Divided per Condition Regarding the Experience of the Trauma Film*

	Overall		Tetris condition		Control condition	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Attention	93.14	8.59	92.55	9.70	93.71	7.37
Distress	57.44	24.93	56.43	26.39	58.41	23.54
Closed eyes	7.11	10.42	8.59	12.92	5.67	6.99

Table 2*Results Experimental Checks per Condition Regarding Diary Completion*

	Overall		Tetris		Control	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Unable/forgot to record intrusions	10.61	19.95	11.61	22.30	9.62	17.42
Accuracy	86.20	11.28	84.39	12.11	87.97	10.16
Effect daily email	20.58	24.41	21.74	25.17	19.44	23.74

Diary instructions

To reduce the error in recording intrusions eight questions (yes/no) were asked to ensure that the participant understood the diary instructions. All participants scored yes on all questions with one exception. One participant indicated “no” on the question “I understand that I should be recording the involuntary memories when they are brief or lengthy”.

Diary completion

In Table 2 participants indicated the extent to which they forgot or were unable to record intrusions in the diary, the accuracy of their reporting, and the effect the daily email reminder had on the amount of intrusions on a scale from 0-100.

Hypothesis testing

Hypothesis 1- Mood change

A paired samples t-test was conducted to determine whether there was a statistically significant mean difference between negative mood before and after watching a trauma film. There were 5 outliers detected that were more than 1.5 box-lengths from the edge of the box in a boxplot. Inspection of their values did not reveal them to be extreme and there was no theoretical reason to exclude them, thus they were kept in the analysis. For a comparison, please refer to Table 1 in the appendix for analysis results without the influence of outliers. The differences between pre-and post-film mood averages were not normally distributed, as assessed by visual inspection of a Normal Q-Q plot (Figure 1 in the Appendix). However, according to the central limit theorem, the sample is large enough ($n = 153$) to assume normality anyway (Pallant, 2010). There was a statistically significant increase in average mood scores from the pre-test ($M = 6.79, SD = 7.24$) to the post-test ($M = 21.42, SD = 16.96$), $t(153) = 11.63, p < 0.001$ (one-tailed). The mean increase was 14.63 ($SD = 15.60$; 95% CI: 12.14 – 17.11). The effect size (Cohen's d) is large ($d = 0.94$).

Hypothesis 2- Correlations between mood change and intrusion measures

The relationship between mood change and IMS intrusions and mood change and image-based diary intrusions was investigated using Spearman's rank correlations. Based on visual inspections of Normal Q-Q plots the normality assumption was violated in both conditions for both intrusion-dependent variables (please refer to Figures 2 -5 in the Appendix). However, according to the central limit theorem normality can be assumed anyway (Pallant, 2010). Visual inspection of scatterplots revealed that linearity was violated

Table 3*Spearman's Rank Correlations in Both Conditions*

	Tetris condition (n=76)		Control condition (n=77)	
	Diary intrusions	IMS score	Diary intrusions	IMS score
Mood change	.300*	.434*	.074	.063

Note. *= statistically significant at $p < .05$ level.

in both conditions, but the relationship was approximately monotonic (see Figures 6-11 in the appendix). Thus, Spearman's rank correlations were investigated. There were 49 outliers that were not removed because there is no theoretical justification. Overall, there was a weak, statistically significant positive correlation between mood change and image-based diary intrusions $r_s(151) = 0.215, p = .008$ and a weak, statistically significant positive correlation between mood change and IMS intrusions $r_s(151) = 0.276, p < 0.001$. In Table 3 the correlations between both conditions can be seen.

Hypothesis 3 – Moderator analysis

Using a z-test it was investigated whether the correlations between mood change and image-based diary intrusions and mood change and IMS intrusion scale would be different for the experimental Tetris condition and the control condition. The correlation between mood change and image-based diary intrusions yielded a negative outcome ($z = -1.472, p = 0.077$) (see Picture 1 in the Appendix) with the z-statistic falling into the range of -1.96 and 1.96, indicating a non-significant difference of correlations between conditions. Conversely, the correlation between mood change and IMS scores yielded a statistically significant positive outcome ($z = 2.435, p = 0.007$) (see Picture 2 in the Appendix). However, the z-statistic exceeded the previously mentioned range, indicating a statistically significant difference between conditions.

Table 4*Difference in Mood After Watching the Trauma Film*

Subscale	Difference between conditions		$t(153)$	p	Cohen's d
	M	SD			
Overall	14.63	15.60	11.63	<0.01	0.94
Sad	7.96	20.22	4.89	<0.01	0.39
Hopeless	4.58	15.43	3.69	<0.01	0.30
Fearful	14.79	21.38	8.58	<0.01	0.69
Horrorified	34.16	28.51	14.87	<0.01	1.20
Anxious	18.66	22.10	10.48	<0.01	0.84
Depressed	7.63	14.02	6.75	<0.01	0.54

Exploratory analysis

A paired samples t-test was conducted to test the difference in mood change between the six different emotions of the mood measure. There was a statistically significant increase in negative mood from before watching the trauma film ($M = 6.79$, $SD = 7.24$) to after ($M = 21.42$, $SD = 16.96$), $t(153) = 11.63$, $p < .0001$ (two-tailed). The mean increase was 14.63 with a 95% confidence interval ranging from 12.15 to 17.15. The Cohen's d statistic (0.94) indicated a large effect size.

Discussion

The current study had several aims. Firstly, to explore if there would be a change in mood after watching a trauma film. Furthermore, to see whether the emotional reaction to analog trauma is a factor that is associated with the development of intrusions. Finally, if

performing a WM task (Tetris) after watching a trauma film has an effect on the amount of intrusions one develops. Mood change was assessed using a paired samples t-test and results supported the hypothesis that there would be an increase in negative mood after watching a trauma film. After, correlations between mood change and the frequency of intrusions in a diary and scores on the IMS intrusion subscale were calculated separately for both conditions. The results supported the hypothesis that there would be a positive correlation between mood change and IMS scores and between mood change and diary intrusions. Finally, it was tested whether there was a significant difference between conditions by calculating the Fisher Z-statistic for both intrusion-based measures. The results partly supported the hypothesis. There was a statistically significant difference between the conditions when it comes to the correlation between mood change and IMS intrusions but not regarding the correlation between mood change and diary intrusions.

The values of the experimental checks indicate an overall high adherence to instructions during the experiment. First, it was checked whether participants paid attention to the trauma film, the extent to which they closed their eyes, and the distress they experienced during the film. It seemed that participants regardless of condition paid good attention to the film and did not close their eyes often. Additionally, participants indicated to have experienced distress which is in line with findings from the post-film mood measure in the current study.

Secondly, all participants indicated to have understood the diary instructions. This suggests that any difference in diary intrusions is not due to a lack of understanding of what should have been reported in the diary. Additionally, the extent to which participants were unable to or forgot to record intrusions in the diary and the self-reported accuracy with which they recorded intrusions suggests that there was fair accuracy, with the control condition judging their accuracy slightly higher than the experimental condition. Additionally,

participants in the control condition indicated that they were slightly less unable or forgetful in recording the intrusions.

Lastly, reminders of the film could have an influence on the frequency of intrusions. While unwanted reminders are commonly experienced by individuals with intrusions or PTSD, their presence could have potentially impacted the outcomes of the present study. One part of the experiment was that each day a reminder email was sent to the participants to remind them to fill in the diary. Some participants did report in their diaries that the email made them have intrusions. Conversely, some participants reported not having looked at the emails at all during the week. To summarize, inspection of the experimental checks suggest that participants did understand how to report their intrusions, usually did not forget to do so, and did so in an accurate manner. This suggests that there was good adherence to the instructions and overall, it is unlikely that an under- or overreporting of intrusions occurred. This result could be influenced by the need for socially desirable responding. Furthermore, it seems that participants paid good attention to the trauma film and were not distracted indicating that the variability of results lies within the person and is not due to circumstances.

Results suggested that, as predicted, there was a statistically significant increase in mood scores from pre-test to post-test. This suggests that participants experience a more negative mood after exposure to the trauma film. These findings are in line with previous research (Holmes et al., 2008; Holmes et al., 2010). Furthermore, the TFP aims to simulate intrusions and emotional responses experienced in real-life trauma within a laboratory setting. The increase in negative emotions after watching the trauma film suggests that the paradigm successfully evokes emotional reactions which may be akin to traumatic experiences. Thus, these findings suggest support for the use of the TFP in research (Holmes & Bourne, 2008).

Contrary to the prediction, Spearman's rank correlations revealed statistically significant correlations between mood change and both diary intrusions and IMS scores in the

Tetris condition. Moreover, the correlations between mood change and both intrusion-based outcome variables were non-significant in the control condition. Stronger correlations were expected in the control condition compared to the Tetris condition which would have suggested an interfering effect of playing Tetris during the cognitive and emotional processing of the trauma film. However, the opposite was found. Both correlations in the control condition were nonsignificant and weak. This suggests that the emotional impact of watching the trauma film is likely not associated with the intrusion frequency reported in the diary and scores on the IMS intrusion subscale. Thus, other factors may be more influential on intrusion development than the experienced mood change. These findings contradict prior research. Clark et al. (2014) found that a low emotional response (regardless if it was fearful or depressive) was significantly related to an absence of intrusions and concluded that a low emotional response to a trauma film seems protective against the development of intrusions. Additionally, Laposa and Alden (2008) came to similar conclusions. It is important to note that there was a difference in samples. Whereas Laposa and Alden (2008) were interested to see whether trait anxiety and depression were related to the development of intrusions, the current study specifically excluded participants that indicated elevated depression and anxiety levels or the recent experience of PTSD symptoms. In the other study, it was reported that trait anxiety, trauma history, and current depression levels were assessed in most of the 16 experiments that were examined but it is unknown whether participants with elevated scores were excluded or not (Clark et al., 2014). However, the significant correlations in the Tetris conditions suggest that the intrusion reports increase when negative mood increases. The weak correlation between mood change and image-based diary intrusions in the Tetris condition suggest that other factors likely contribute more substantially to intrusion development. Furthermore, the moderate correlation between mood change and IMS intrusions suggests a more robust association.

The Fisher's Z-test indicated a positive and statistically significant difference between the Tetris and control conditions concerning the association between mood change and IMS intrusions. This suggests a more pronounced or robust correlation in the Tetris condition than the control condition, which contradicts the prediction. It was predicted that there would be a stronger correlation between mood change and intrusion-based variables in the control condition, which would have suggested an interference effect of playing Tetris due to the reallocation of cognitive WM sources. This assumption underlays all research regarding the effect Tetris has on intrusion development. Additionally, the test revealed a negative and nonsignificant difference between conditions for the correlation between mood change and diary intrusions. This suggests that the correlation is of similar strength between both conditions.

While correlations regarding the diary intrusions were overall weak the IMS intrusion subscale shows a significant moderate correlation. The IMS intrusion subscale does not provide a quantitative measure of intrusion frequency and is a retrospective self-report of the experienced distress of possible intrusion symptoms. While some items on the scale ask about the emergence of intrusions (e.g., "Other things kept making me think about it", "Pictures popped into my mind about it", "I found myself acting or feeling like I was back at that time") other items assessed symptoms that potentially accompany intrusions (e.g. "I had trouble staying asleep", "I had dreams about it"). Thus, the IMS scores do not only reflect the frequency of intrusions as the diary measure does. Summing and averaging those scores could influence the reported correlations. This suggests that the perceived distress accompanying intrusions is associated with the heightened negative mood after a trauma, whereas the frequency of intrusions is to a lesser extent. This suggests the question of whether the emphasis of an intervention should target the frequency of intrusions or rather the emotional valence they carry.

In the current study, only image-based intrusions were assessed and purely thought-based intrusions were excluded. This was done because the Tetris task is supposed to tax the visual-spatial WM. Additionally, prior research was focused solely on image-based intrusions as well (Hagenaars et al., 2017; Holmes et al., 2020; James et al., 2015). However, there is no direct way of measuring whether Tetris actually taxes the visual-spatial WM.

While some studies reported a beneficial effect of playing Tetris on intrusion development (Badawi et al., 2020; Holmes et al., 2009; Holmes et al., 2010; Horsch et al., 2017; Iyadurai et al., 2017) the current results suggest a more pronounced correlation with negative emotions when playing Tetris after watching a trauma film. The exact effect of Tetris on the relationship of negative emotion and intrusion development thus needs to be more closely examined. Still it appears that there is some benefit of Tetris as a therapeutic tool. In a study conducted by Butler et al. (2020) male participants with PTSD were instructed to play Tetris daily over the course of 6 weeks together with Eye Movement Desensitization and Reprocessing therapy (EMDR) and were compared to a therapy-only group. They found that the hippocampal volume increased in the Tetris group but not in the control group and that this increase was correlated with reduced PTSD symptoms, depression, and anxiety. More specifically, the Tetris group showed a continued reduction in anxiety at the 6-month follow-up mark. This suggests that Tetris could be a viable option as a therapeutic tool for brain-training and gives further support to the notion that playing Tetris has an effect on intrusion development.

Results suggest that there is a wide range of how many intrusions an individual develops. Although the majority of individuals do not experience a high frequency of intrusions, some exhibit significantly higher scores. Additional investigation is necessary to comprehend the varying patterns of intrusion development and identify the contributing

factors. Moreover, a more comprehensive understanding of the association between playing Tetris and the development of intrusions is required.

In an exploratory analysis of the results, mood was assessed along six subscales (sadness, hopelessness, fearfulness, horror, anxiousness, depression). Negative mood increased significantly on each scale. Exploratory analysis regarding the different subscales of the mood measure revealed that Cohen's d differed between the different subscales but not much between conditions. While depression and hopelessness showed moderate effect sizes in both conditions, all other subscales (sadness, fearfulness, horror, and anxiousness) show large effect sizes in both conditions. Firstly, this suggests that there was not much difference in the emotional experience between the conditions and the results of the analyses are not likely to differ because of this. Previous research linked trait anxiety and trait depression to the development of intrusions (Clark et al., 2014; Laposa & Alden, 2008). Current results suggest that there is a large increase in anxiousness but only a moderate increase in depression. It is important to note that the scale which was used does not assess trait anxiety and depression, and participants who had elevated anxiety and depression scores on the screening instruments were excluded due to ethical considerations in this study. Clark et al. (2014) and Laposa and Alden (2008) argued that their findings are in line with the notion that the DSM-5 removed the need for a specific emotional response (American Psychiatric Association, 2013). Although the current findings do not suggest the contrary, the large effect sizes along the subscale could lend clues to the emotional experience trauma evokes and might emphasize the need to decrease specific emotions. Furthermore, prior research by Holmes et al. (2005) suggests that some intrusions occur more frequently than others and are linked to different emotional distress (e.g., participants, on average, have more intrusions concerning control and reasoning compared to abandonment). Exploring these cognitive themes and conducting correlational research with the experienced mood change could

possibly lead to a more detailed understanding of what emotions are related to intrusion development. This could lead to a better understanding of beneficial interventions in the treatment of recently traumatized individuals. The moderate effect sizes for depression and hopelessness suggest that these emotions might follow later and are not elevated when the trauma was experienced recently. This information could help in the assessment and treatment of recently traumatized individuals by first-line respondents (e.g., paramedics, police departments, or hospitals).

Limitations

There are several limitations concerning the methodology of the current study. First, the results show that there are significantly positive correlations between mood change and diary intrusions and scores on the IMS intrusion scale. However, both correlations are weak. This could be connected to the lack of reliability and validity of the diary measure. Indeed, most studies use a week-long diary to record the frequency of intrusions, but no research currently supports this use. Similar criticism was raised by Christea et al. (2018) on the Iyadurai et al. (2017) study. On the other hand, the other outcome measure, the IMS intrusion scale, is reliable and valid. Furthermore, it could be possible that there would be larger positive correlations if a real-life trauma is experienced. Even though the TFP can induce analogous intrusions (Holmes & Bourne, 2008) it could be that real-life trauma serves a bigger threat to the person which could be accompanied by a greater negative mood.

Additionally, trauma prevalence was found to differ along trauma (Santiago et al., 2013). Prevalence increases for individuals who experienced an intentional trauma (e.g., rape or abuse) compared to people who experienced non-intentional traumas (e.g., natural disasters). Currently, there is a lack of research investigating whether scenes in trauma films or real-life traumatic experiences, perceived as particularly horrifying or anxiety-inducing, have different effects on the development of intrusions. Furthermore, it could be that people

experience greater negative emotions when they watch a trauma film including scenes of intentional trauma. It is not clear yet what exact role negative mood plays in the development of intrusions and their maintenance.

Thirdly, different mental health problems could predispose a person to be influenced easier by emotions or experience emotions more intensely, which could lead to a higher intrusion frequency. This could explain why other research on the association of emotions and intrusions shows a clear correlation between anxiety and depression to intrusion frequency (Clark et al., 2014; Lapsa & Alden, 2008). This sample consisted of undergraduate psychology students who are assumed to be healthy due to the exclusion criteria during the screening process. It could be possible that individuals with the aforementioned vulnerabilities are more likely to experience a higher frequency of intrusions. Thus, it is debatable whether findings are generalizable to a broader population.

Fourthly, participants who had a lot of reminders in the week following the trauma film could have experienced more intrusions than participants who had less. For example, in one scene a person was attacked by a bear, logically if a person were to watch a documentary about bears, they could be reminded more easily of this scene in the trauma film and subsequently report more intrusions. While unwanted reminders are commonly experienced by individuals with intrusions or PTSD, their presence could have potentially impacted the outcomes of the present study.

Finally, the results could have been influenced by the adherence to instructions while watching the trauma film and filling in the diary or the email reminder. The scores were inspected for the experimental checks concerning the aforementioned factors and were deemed to likely not be influential. However, no analyses were performed and thus no conclusion can be drawn.

Future research

Future research should be conducted with a larger, more diverse sample and preferably use participants who have experienced real-life trauma. This would improve the generalizability of findings. Furthermore, it could be that even though the trauma film has reliably been found to induce intrusions these qualitatively differ from real-life trauma. Thus, we recommend further research akin to Horsch et al. (2017) and Iyuarai et al. (2017), preferably with larger samples. In an effort to understand the link between the emotional experience during a traumatic event and the perceived distress accompanying intrusions an item analysis of the IMS intrusion subscale could be done to figure out which items are associated with negative emotions. This could possibly elucidate the understanding of PTSD and inform trauma treatment. Moreover, the link between personality factors and vulnerabilities to the emotional experience should be highlighted. It could be that the negative emotional experience is mediated by those which could explain the other experimental results (Clark et al. 2014, Laposa & Alden, 2008).

Conclusion

In conclusion, this study aimed to investigate the relationship between emotional reactions and the development of intrusions after watching a trauma film. The results supported the hypothesis that there would be an increase in negative mood after viewing the film. Correlation analyses showed a weak but significant positive association between mood change and image-based diary intrusions and a significant moderate correlation between mood change and IMS intrusion scores in the Tetris condition. However, there was no significant correlations in the control condition. The Fisher's Z-test revealed a significant difference between the Tetris and control conditions regarding the association between mood change and IMS intrusions. However, there was no significant difference between conditions in the correlation between mood change and diary intrusions. These patterns contradict prior research which suggests that findings suggest that emotional reactions play a role in intrusion

development and that playing Tetris after a trauma film can influence this relationship. The study also highlighted the need for further investigation into the specific emotions associated with intrusion development. Limitations included the use of undergraduate psychology students as participants and the potential impact of reminders on intrusion frequency. Future research should involve larger and more diverse samples, including individuals with real-life trauma experiences.

References

- American Psychiatric Association. (2022). *Diagnostic and Statistical Manual of Mental Disorders, Text Revision Dsm-5-tr* (5th ed.). Amer Psychiatric Pub Inc.
- Asselbergs, J., Sijbrandij, M., Hoogendoorn, E., Cuijpers, P., Olie, L., Oved, K., Merkies, J., Plooijer, T., Eltink, S., & Riper, H. (2018). Development and Testing of TraumaGameplay: an Iterative Experimental Approach Using the Trauma Film Paradigm. *European Journal of Psychotraumatology*, 9(1).
<https://doi.org/10.1080/20008198.2018.1424447>
- Badawi, A., Berle, D., Rogers, K., & Steel, Z. (2020). Do Cognitive Tasks Reduce Intrusive-Memory Frequency After Exposure to Analogue Trauma? An Experimental Replication. *Clinical Psychological Science*, 8(3), 569–583.
<https://doi.org/10.1177/2167702620906148>
- Birur, B., Moore, N. C., & Davis, L. L. (2016). An Evidence-Based Review of Early Intervention and Prevention of Posttraumatic Stress Disorder. *Community Mental Health Journal*, 53(2), 183–201. <https://doi.org/10.1007/s10597-016-0047-x>
- Brewin, C. R., Rose, S., Andrews, B., Green, J., Tata, P., McEvedy, C., Turner, S., & Foa, E. B. (2002). Brief Screening Instrument for Post-Traumatic Stress Disorder. *British Journal of Psychiatry*, 181(02), 158–162. <https://doi.org/10.1017/s0007125000161896>
- Butler, O., Herr, K., Willmund, G., Gallinat, J., Kühn, S., & Zimmermann, P. (2020). Trauma, Treatment and Tetris: Video Gaming Increases Hippocampal Volume in Male Patients with Combat-Related Posttraumatic Stress Disorder. *Journal of Psychiatry and Neuroscience*, 279–287. <https://doi.org/10.1503/jpn.190027>
- Clark, I. A., Mackay, C. E., & Holmes, E. A. (2014). Low Emotional Response to Traumatic Footage is Associated with an Absence of Analogue Flashbacks: An individual

- Participant Data Meta-Analysis of 16 Trauma Film Paradigm Experiments. *Cognition and Emotion*, 29(4), 702–713. <https://doi.org/10.1080/02699931.2014.926861>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cristea, I. A., Naudet, F., Shanks, D. R., & Hardwicke, T. E. (2018). Post-Retrieval Tetris Should Not be Likened to a ‘Cognitive Vaccine.’ *Molecular Psychiatry*, 23(10), 1972–1973. <https://doi.org/10.1038/mp.2017.222>
- Deepröse, C., Zhang, S., DeJong, H., Dalgleish, T., & Holmes, E. A. (2012). Imagery in the Aftermath of Viewing a Traumatic Film: Using Cognitive Tasks to Modulate the Development of Involuntary Memory. *Journal of Behavior Therapy and Experimental Psychiatry*, 43(2), 758–764. <https://doi.org/10.1016/j.jbtep.2011.10.008>
- Ehlers, A., Hackmann, A., Steil, R., Clohessy, S., Wenninger, K., & Winter, H. (2002). The Nature of Intrusive Memories after Trauma: the Warning Signal Hypothesis. *Behaviour Research and Therapy*, 40(9), 995–1002. [https://doi.org/10.1016/s0005-7967\(01\)00077-8](https://doi.org/10.1016/s0005-7967(01)00077-8)
- Hagenaars, M. A., Holmes, E. A., Klaassen, F., & Elzinga, B. (2017). Tetris and Word Games Lead to Fewer Intrusive Memories when Applied Several Days after Analogue Trauma. *European Journal of Psychotraumatology*, 8(sup1), 1386959. <https://doi.org/10.1080/20008198.2017.1386959>
- Holmes, E. A. (2003). Intrusive, Emotional Mental Imagery and Trauma: Experimental and Clinical Clues. *Imagination, Cognition and Personality*, 23(2), 147–154. <https://doi.org/10.2190/hjg1-7uph-b3k0-p9h5>
- Holmes, E. A., & Bourne, C. (2008). Inducing and Modulating Intrusive Emotional Memories: A Review of the Trauma Film Paradigm. *Acta Psychologica*, 127(3), 553–566. <https://doi.org/10.1016/j.actpsy.2007.11.002>

- Holmes, E. A., Grey, N., & Young, K. A. (2005). Intrusive Images and “Hotspots” of Trauma Memories in Posttraumatic Stress Disorder: an Exploratory Investigation of Emotions and Cognitive Themes. *Journal of Behavior Therapy and Experimental Psychiatry*, 36(1), 3–17. <https://doi.org/10.1016/j.jbtep.2004.11.002>
- Holmes, E. A., James, E. L., Coode-Bate, T., & Deepro, C. (2009). Can Playing the Computer Game “Tetris” Reduce the Build-Up of Flashbacks for Trauma? A Proposal from Cognitive Science. *PLoS ONE*, 4(1), e4153. <https://doi.org/10.1371/journal.pone.0004153>
- Horsch, A., Vial, Y., Favrod, C., Harari, M. M., Blackwell, S. E., Watson, P. H., Iyadurai, L., Bonsall, M. B., & Holmes, E. A. (2017). Reducing Intrusive Traumatic Memories after Emergency Caesarean Section: A Proof-of-Principle Randomized Controlled Study. *Behaviour Research and Therapy*, 94, 36–47. <https://doi.org/10.1016/j.brat.2017.03.018>
- Iyadurai, L., Blackwell, S. E., Meiser-Stedman, R., Watson, P. C., Bonsall, M. B., Geddes, J. R., Nobre, A. C., & Holmes, E. A. (2017). Preventing Intrusive Memories after Trauma via a Brief Intervention Involving Tetris Computer Game Play in the Emergency Department: a Proof-of-Concept Randomized Controlled Trial. *Molecular Psychiatry*, 23(3), 674–682. <https://doi.org/10.1038/mp.2017.23>
- James, E. L., Bonsall, M. B., Hoppitt, L., Tunbridge, E. M., Geddes, J. R., Milton, A. L., & Holmes, E. A. (2015). Computer Game Play Reduces Intrusive Memories of Experimental Trauma via Reconsolidation-Update Mechanisms. *Psychological Science*, 26(8), 1201–1215. <https://doi.org/10.1177/0956797615583071>
- James, E. L., Lau-Zhu, A., Tickle, H., Horsch, A., & Holmes, E. A. (2016). Playing the Computer Game Tetris Prior to Viewing Traumatic Film Material and Subsequent

- Intrusive Memories: Examining Proactive Interference. *Journal of Behavior Therapy and Experimental Psychiatry*, 53, 25–33. <https://doi.org/10.1016/j.jbtep.2015.11.004>
- Kensinger, E. A., & Corkin, S. (2003). Effect of Negative Emotional Content on Working Memory and Long-Term Memory. *Emotion*, 3(4), 378–393. <https://doi.org/10.1037/1528-3542.3.4.378>
- Laposa, J. M., & Alden, L. E. (2008). The Effect of Pre-Existing Vulnerability Factors on a Laboratory Analogue Trauma Experience. *Journal of Behavior Therapy and Experimental Psychiatry*, 39(4), 424–435. <https://doi.org/10.1016/j.jbtep.2007.11.002>
- Miao, X., Chen, Q., Wei, K., Tao, K., & Lu, Z. (2018). Posttraumatic Stress Disorder: from Diagnosis to Prevention. *Military Medical Research*, 5(1). <https://doi.org/10.1186/s40779-018-0179-0>
- Page, S., & Coxon, M. (2017). Preventing Post-Traumatic Intrusions Using Virtual Reality. *Annual Review of Cybertherapy and Telemedicine*, 15, 21.
- Pallant, J. (2010). *SPSS Survival Manual a Step by Step Guide to Data Analysis Using the SPSS Program* (4th ed.). Open University Press.
- Reilly, T., MacGillivray, S., Reid, I. R., & Cameron, I. M. (2015). Psychometric Properties of the 16-item Quick Inventory of Depressive Symptomatology: A Systematic Review and Meta-Analysis. *Journal of Psychiatric Research*, 60, 132–140. <https://doi.org/10.1016/j.jpsychires.2014.09.008>
- Rush, A., Trivedi, M. H., Ibrahim, H. M., Carmody, T. J., Arnow, B., Klein, D. N., Markowitz, J. C., Ninan, P. T., Kornstein, S., Manber, R., Thase, M. E., Kocsis, J. H., & Keller, M. B. (2003). The 16-Item Quick Inventory of Depressive Symptomatology (QIDS), Clinician Rating (QIDS-C), and Self-Report (QIDS-SR): a Psychometric Evaluation in Patients with Chronic Major Depression. *Biological Psychiatry*, 54(5), 573–583. [https://doi.org/10.1016/s0006-3223\(02\)01866-8](https://doi.org/10.1016/s0006-3223(02)01866-8)

- Santiago, P. N., Ursano, R. J., Gray, C. L., Pynoos, R. S., Spiegel, D., Lewis-Fernandez, R., Friedman, M. J., & Fullerton, C. S. (2013). A Systematic Review of PTSD Prevalence and Trajectories in DSM-5 Defined Trauma Exposed Populations: Intentional and Non-Intentional Traumatic Events. *PLoS ONE*, 8(4), e59236.
<https://doi.org/10.1371/journal.pone.0059236>
- Stoet, G. (2010). PsyToolkit: A Software Package for Programming Psychological Experiments using Linux. *Behavior Research Methods*, 42(4), 1096–1104.
<https://doi.org/10.3758/BRM.42.4.1096>
- Stoet, G. (2017). PsyToolkit: A Novel Web-Based Method for Running Online Questionnaires and Reaction-Time Experiments. *Teaching of Psychology*, 44(1), 24–31.
<https://doi.org/10.1177/0098628316677643>
- Weiss, D. S., Marmar, C. R., Wilson, J. P., & Keane, T. M. (Eds.). (1997). *The Impact of Event Scale—Revised: Assessing psychological trauma and PTSD*. New York, NY: Guilford Press.
- Wessel, I., Van Schie, K., Smeets, T., Albers, C., Ferreira De Sá, D., Michael, T., Pearson, D., Takarangi, M., Nixon, R., Krans, J., & Jaswetz, L. (2021). Playing Tetris to Counteract the Development of Intrusive Memories of Trauma - A Large Sample Multisite Trial [Preregistration of study]. Open Science Framework. Retrieved May 30, 2023, from <https://osf.io/hj8ad> <https://doi.org/10.17605/OSF.IO/64FUW>
- Wilkinson, R. T., & Houghton, D. (1982). Field Test of Arousal: A Portable Reaction Timer with Data Storage. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 24(4), 487–493. <https://doi.org/10.1177/001872088202400409>

Appendix

Figure 1

Normal Q-Q Plot of Mood Change

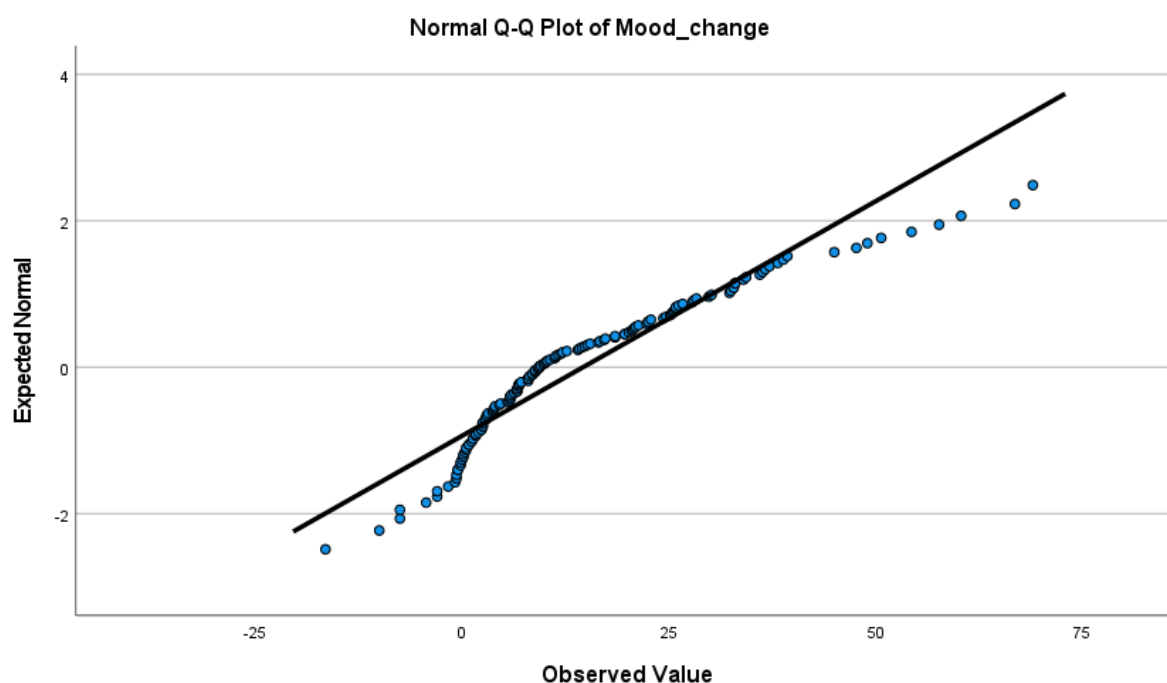


Table 1

Difference in Mood Before and After Watching a Trauma Film Without Outliers

Subscale	Timepoint	Both conditions		Tetris condition		Control condition	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Overall	Pre-film	6.83	7.32	7.53	7.91	6.16	6.69
	Post-film	19.88	14.93	19.81	15.34	19.95	14.62
Sad	Pre-film	9.85	14.56	11.93	17.93	7.86	10.06
	Post-film	16.22	16.82	15.75	16.50	16.67	17.22
Hopeless	Pre-film	5.77	13.48	7.10	15.20	4.49	11.55
	Post-film	9.09	12.86	9.85	13.20	8.37	12.57
Fearful	Pre-film	8.39	11.60	9.55	13.45	7.28	9.44

	Post-film	21.46	20.05	21.49	19.16	21.42	20.99
Horrified	Pre-film	2.07	4.07	1.77	3.13	2.36	4.80
	Post-film	34.53	27.48	35.72	30.33	33.38	24.58
Anxious	Pre-film	11.42	12.57	10.79	10.33	12.01	14.44
	Post-film	28.59	25.00	27.18	24.43	29.95	25.62
Depressed	Pre-film	3.49	7.36	4.04	8.23	2.96	6.43
	Post-film	9.40	13.08	8.86	12.47	9.91	13.71

Figure 2

Normal Q-Q Plot of Diary Intrusions in Tetris Condition

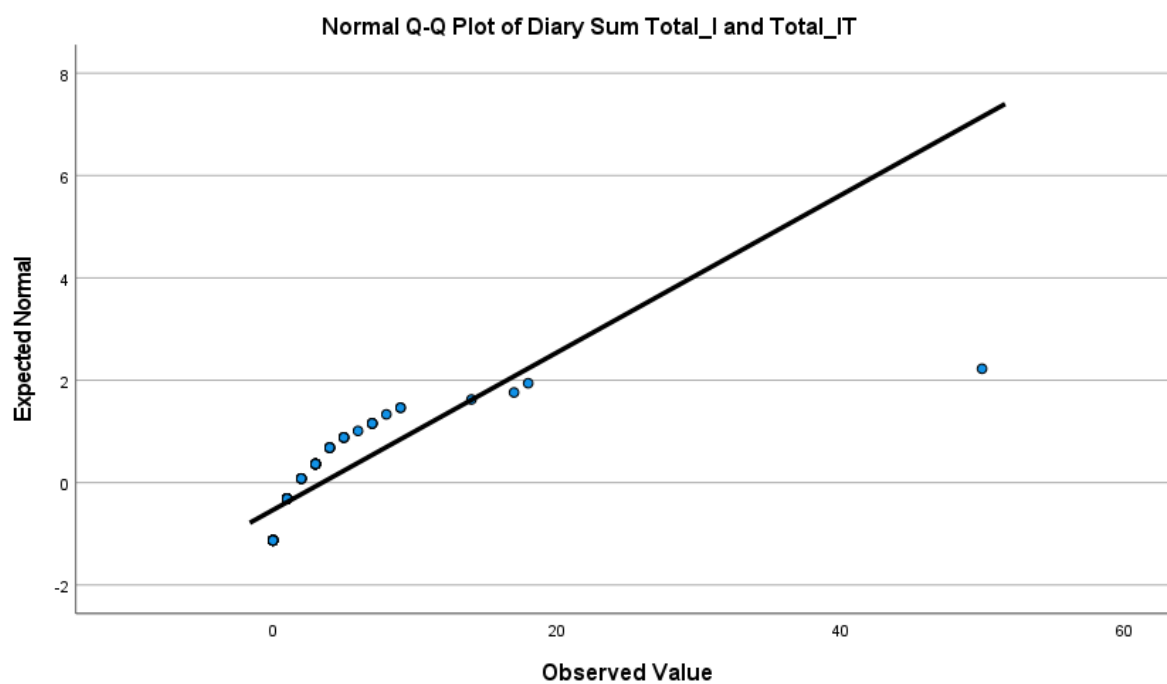


Figure 3

Normal Q-Q Plot of IMS Scores in Tetris Condition

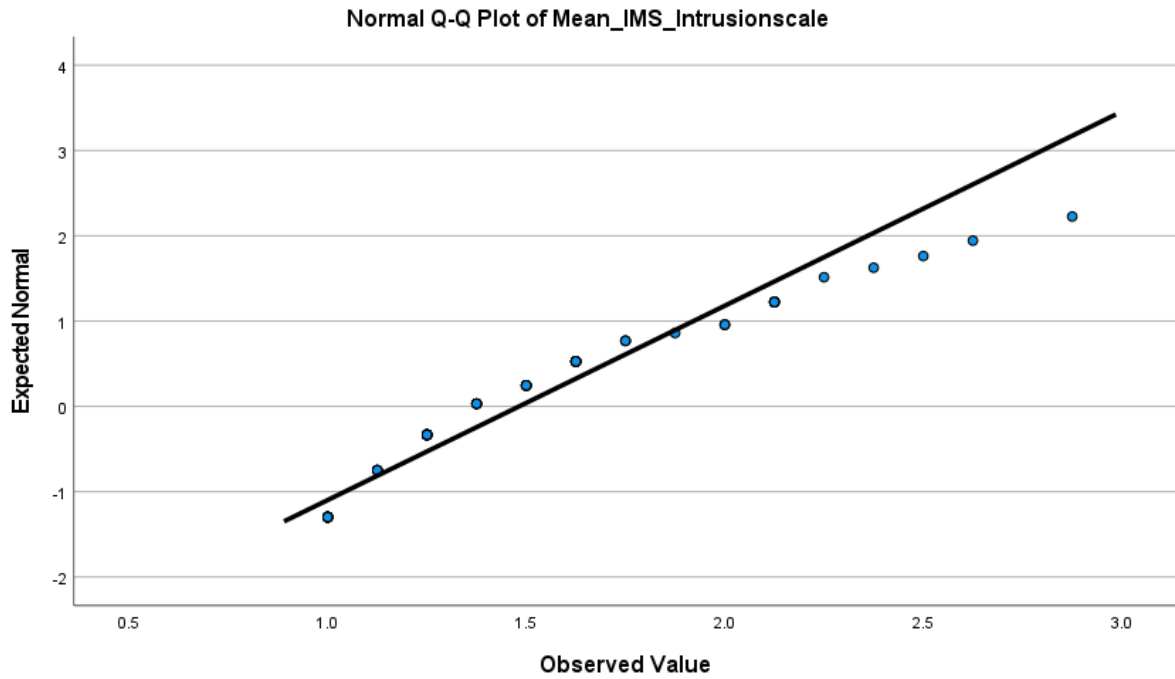


Figure 4

Normal Q-Q Plot of Diary Intrusions in Control Condition



Figure 5

Normal Q-Q Plot of IMS Scores in Control Condition

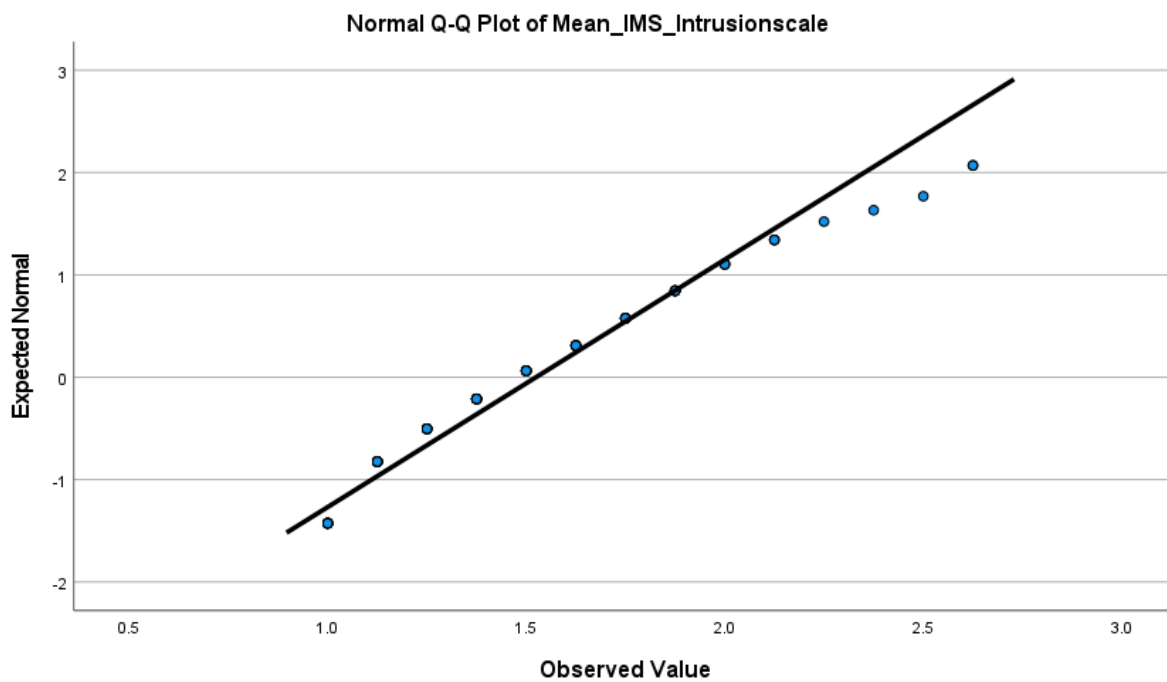


Figure 6

Overall Correlation Between Mood Change and Image-Based Diary Intrusions

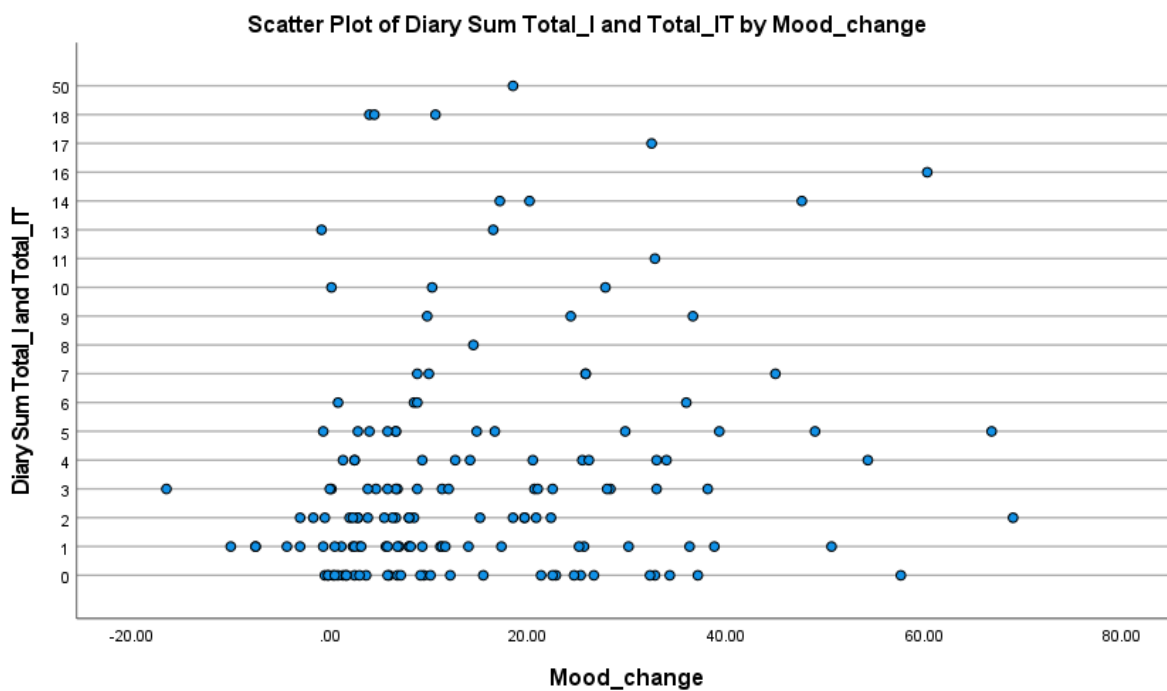


Figure 7

Correlation Between Mood Change and IMS Intrusion-Subscale

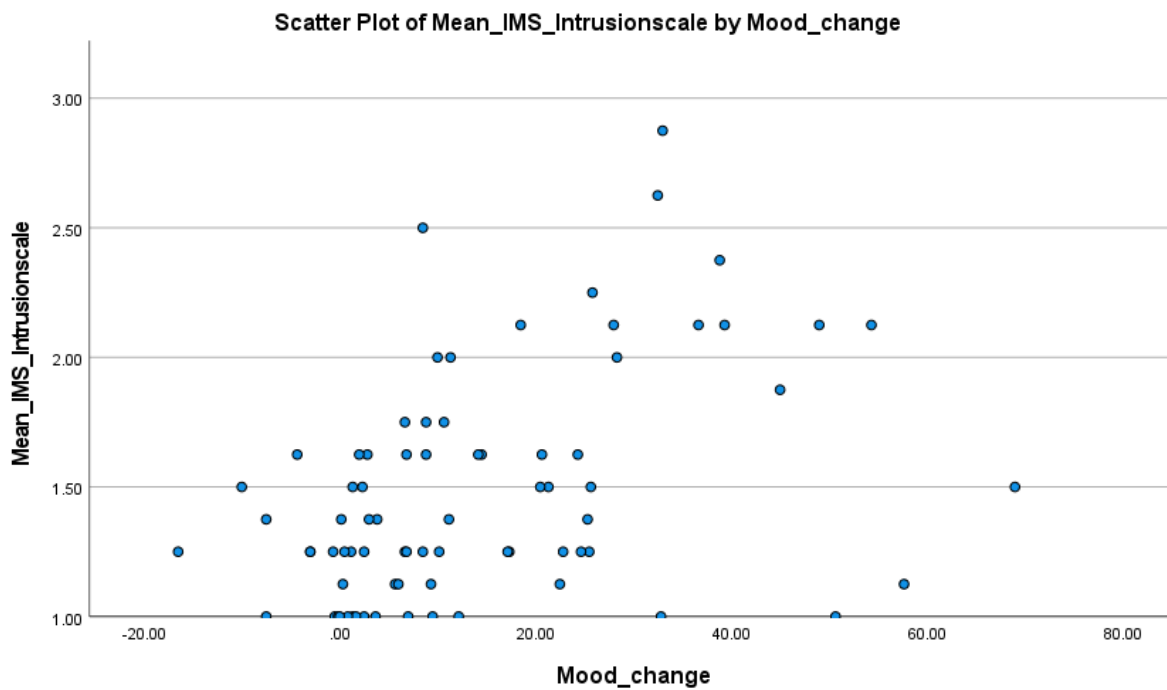


Figure 8

Correlation Between Mood Change and Image-Based Diary Intrusions in Tetris Condition

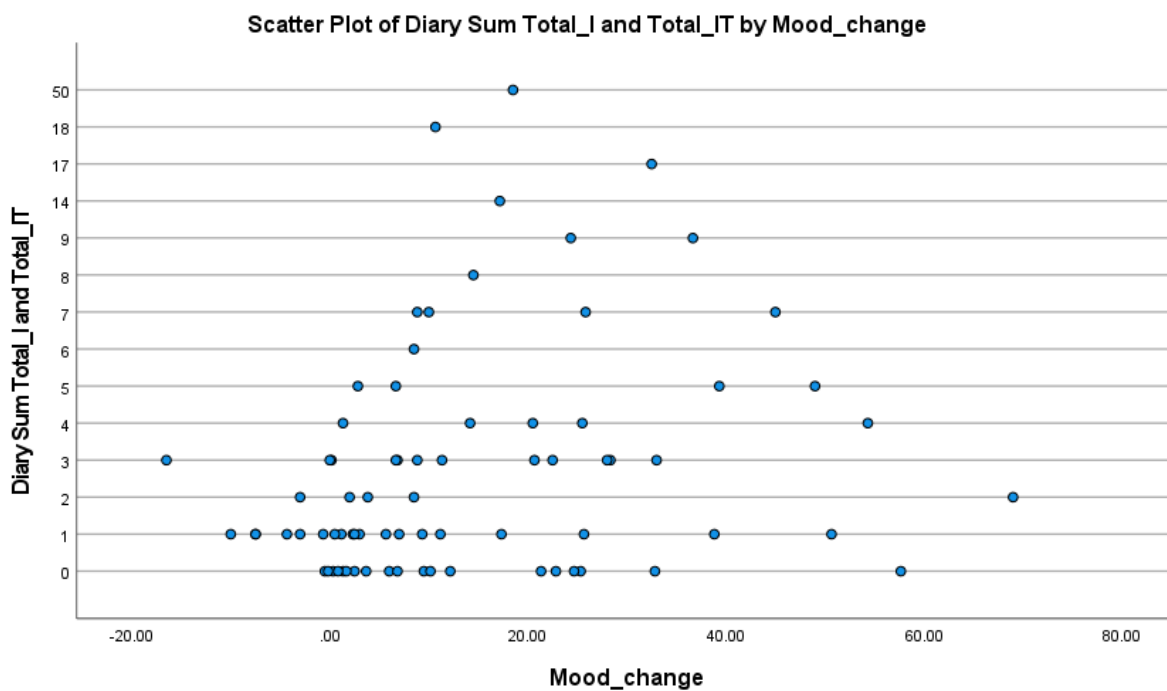


Figure 9

Correlation Between Mood Change and IMS Intrusion-Subscale in Tetris Condition

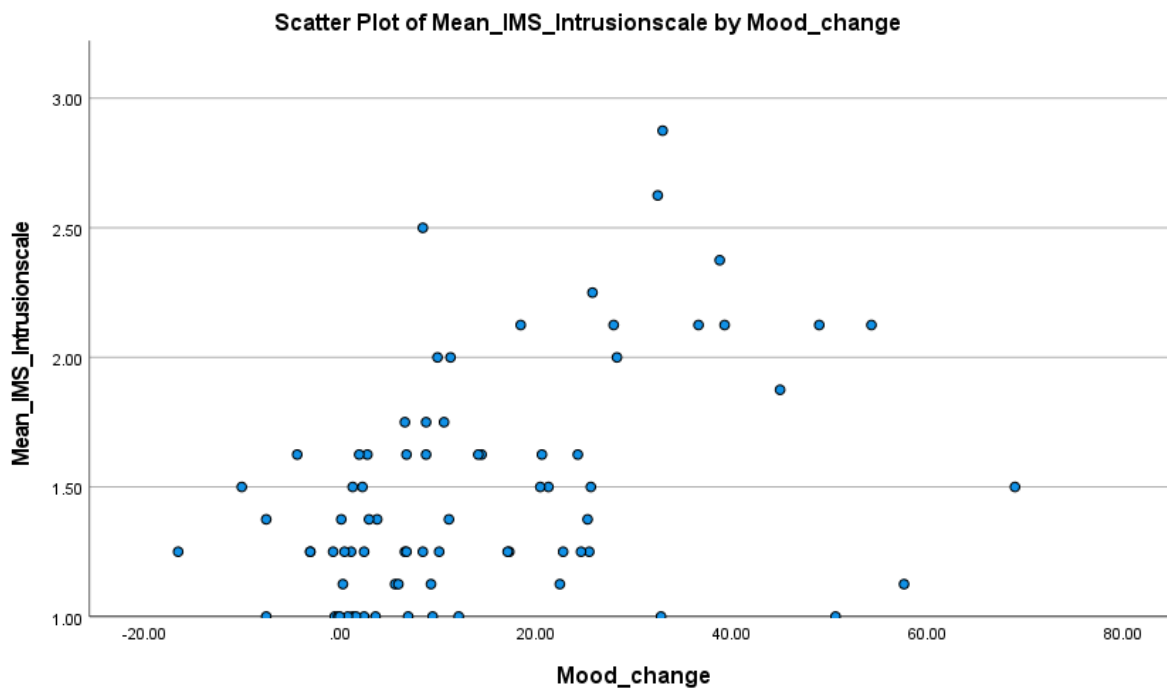


Figure 10

Correlation between Mood Change and Image-Based Diary Intrusions in Control Condition

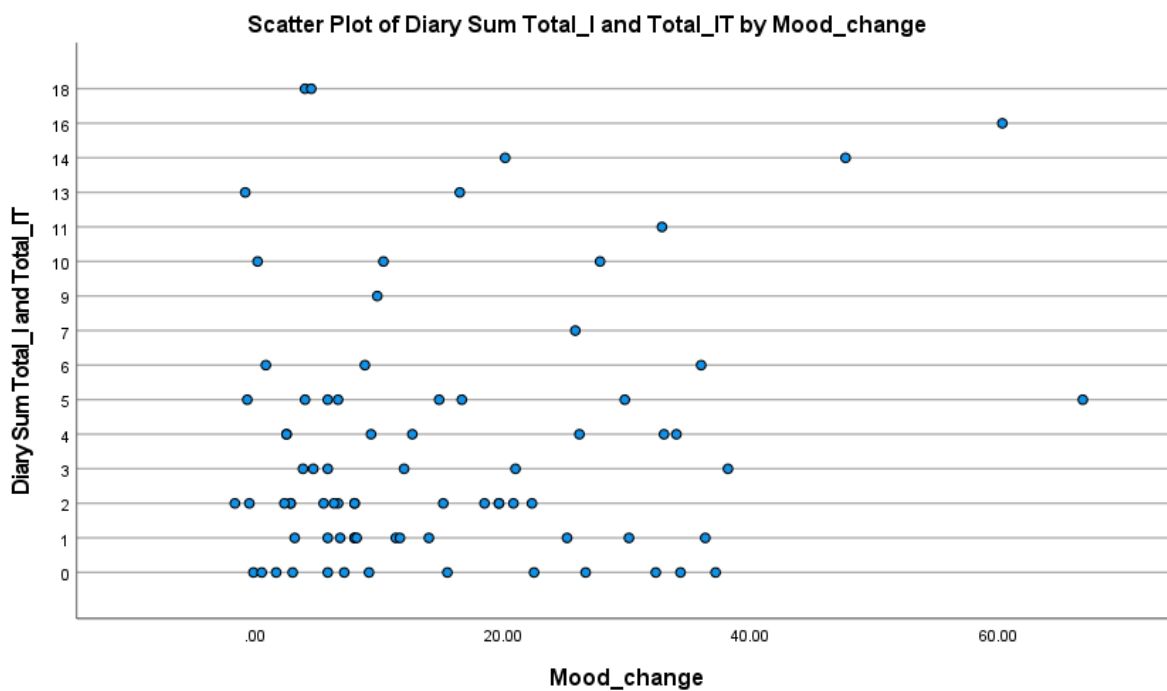
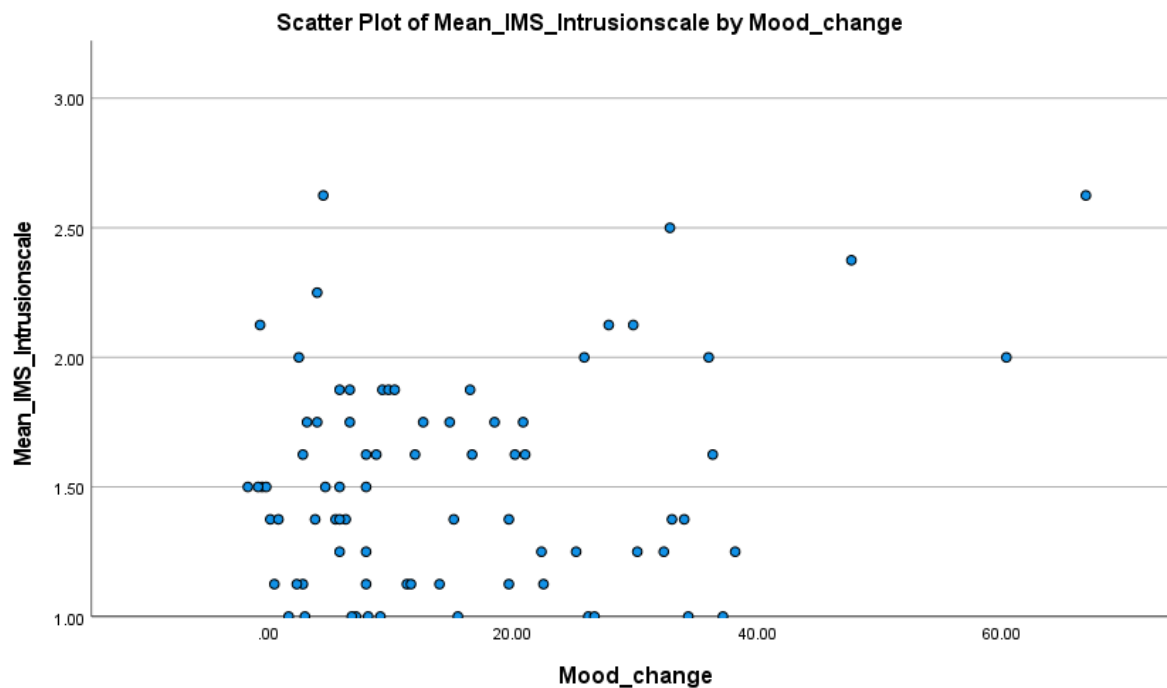


Figure 11

Correlation between Mood Change and IMS Intrusion-Subscale in Control Condition



Picture 1

Testing Significance of Correlations Between Mood Change and Diary Intrusions Between Conditions

	n	r
Correlation 1	76	0.300
Correlation 2	77	0.074
Test Statistic z	1.427	
Probability p	0.077	

(Calculation according to Eid, Gollwitzer & Schmidt, 2011, pp. 547; single sided test)

Picture 2

Testing Significance of Correlations Between Mood Change and IMS Scores Between Conditions

	n	r
Correlation 1	76	0.434
Correlation 2	77	0.063
Test Statistic z		2.435
Probability p		0.007

(Calculation according to *Eid, Gollwitzer & Schmidt, 2011, pp. 547; single sided test*)