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CLINICAL RESEARCH ARTICLE

A randomized controlled dismantling study of Visual Schema Displacement Therapy (VSDT) vs an abbreviated EMDR protocol vs a non-active control condition in individuals with disturbing memories

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ABSTRACT

Background: Visual Schema Displacement Therapy (VSDT) is a novel therapy for the treatment of fears and trauma-related mental health problems including PTSD. VSDT proved to be effective in reducing emotionality of aversive memories in healthy individuals in two previous randomized controlled trials and outperformed both a non-active control condition (CC) and an abbreviated version of EMDR therapy, a well-established first-line treatment for posttraumatic stress disorder.

Objectives: In an effort to enhance the understanding concerning the efficacy of VSDT, and to determine its active components, a dismantling study was conducted in individuals with disturbing memories in which the effects of VSDT were tested against EMDR therapy, a non-active CC and three different VSDT-protocols, each excluding or altering a hypothesized active component.

Method: Participants (N = 144) were asked to recall an emotional aversive event and were randomly assigned to one of these six interventions, each lasting 8 minutes. Emotional disturbance and vividness of participants' memories were rated before and after the intervention and at one and four-week follow-up.

Results: Replicatory Bayesian analyses supported hypotheses in which VSDT was superior to the CC and the EMDR condition in reducing emotionality, both directly after the intervention and at one week follow-up. However, at four-week follow-up, VSDT proved equal to EMDR while both treatments were superior to the CC. Concerning vividness the data also showed support for hypotheses predicting VSDT being equal to EMDR and both being superior to the CC in vividness reduction. Further analyses specifying differences between the abbreviated VSDT protocols detected no differences between these conditions.

Conclusion: It remains unclear how VSDT yields its positive effects. Because VSDT appears to be unique and effective in decreasing emotionality of aversive memories, replication of the results in clinical samples is needed.

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PALABRAS CLAVE

TEPT; VSDT; EMDR; recuerdos emocionales; mecanismos de acción

关键词

PTSD; VSDT; EMDR; 情绪记忆; 工作机制

HIGHLIGHTS

- Visual Schema Displacement Therapy reduces emotionality of disturbing memories.
- Working mechanisms of VSDT are explored.
- VSDT outperforms EMDR in reducing emotionality of disturbing memories.

Un estudio de desmantelamiento controlado aleatorizado de la terapia de desplazamiento del esquema visual (VSDT) versus un protocolo EMDR abreviado versus una condición de control no activa en individuos con recuerdos perturbadores

Antecedentes: La terapia de desplazamiento del esquema visual (VSDT por sus siglas en inglés) es una terapia novedosa para tratar los miedos y los problemas de salud mental relacionados con el trauma, incluido el TEPT. La VSDT demostró ser eficaz para reducir la emocionalidad de los recuerdos aversivos en individuos sanos en dos ensayos previos controlados aleatorizados y superó tanto a una condición de control no activa (CC por sus siglas en inglés) como a una versión abreviada de terapia EMDR, una terapia de primera línea bien establecida para el trastorno de estrés postraumático.

Objetivos: En un esfuerzo para mejorar la comprensión de la eficacia de VSDT y para determinar sus componentes activos, se realizó un estudio de desmantelamiento en individuos con recuerdos perturbadores en el que se probaron los efectos del VSDT en contraste con la terapia EMDR, una CC no activa y tres diferentes protocolos de VSDT, cada uno excluyendo o alterando un componente activo hipotético.

Método: Se pidió a los participantes (N= 144) que recordaran un evento aversivo emocionalmente y fueron asignados aleatoriamente a una de las seis intervenciones, cada una con una duración de 8 minutos. La alteración emocional y la viveza de los recuerdos de los

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participantes fueron calificados antes y después de la intervención y en el seguimiento luego de una y cuatro semanas.
Resultados: Los análisis bayesianos replicativos apoyaron la hipótesis en las que VSDT fue superior a las condiciones CC y EMDR en la reducción de la emocionalidad, tanto directamente después de la intervención y a la semana de seguimiento. Sin embargo, a las cuatro semanas de seguimiento, VSDT resultó ser igual a EMDR mientras que ambos tratamientos fueron superiores al CC. Con respecto a la viveza, los datos también mostraron apoyo hacia las hipótesis que predicen que VSDT es igual a EMDR y que ambos son superiores a CC en la reducción de la viveza. Los análisis adicionales que especifican las diferencias entre los protocolos VSDT abreviados no detectaron diferencias entre estas condiciones.
Conclusiones: No está claro cómo VSDT produce sus efectos positivos. Debido a que VSDT parece ser único y efectivo en disminuir la emocionalidad de los recuerdos aversivos, se requiere la replicación de estos estos resultados en muestras clínicas.

具有痛苦记忆的个体中视觉模式替换治疗 (VSDT) 与简化版EMDR方案和非主动控制条件的随机对照分解研究

背景: 视觉模式置换疗法 (VSDT) 是一种新颖的治疗恐惧和包括PTSD的创伤相关心理健康问题的疗法。 VSDT在先前的两项随机对照试验中被证明可有效降低健康个体的厌恶记忆情绪化, 并且比非主动对照条件 (CC) 和被公认的创伤后应激障碍一线治疗方法——简化版EMDR疗法表现更好。
目的: 为了提高对VSDT功效的了解并确定其有效成分, 对具有痛苦记忆的个体进行了一项分解研究, 其中有VSDT与 EMDR疗法, 非主动CC和三种不同VSDT方案 (每种都排除或更改一个假设的有效成分) 对比检验。
方法: *N* = 144名参与者被要求回忆一次情绪厌恶事件, 并被随机分配到这些每个都持续8分钟的六种干预措施组之一。在干预前, 后以及一, 四个星期的随访中对参与者的情绪痛苦和生动性进行了评估。
结果: 可重复的贝叶斯分析支持在干预后和在一周的随访时VSDT在降低情绪上均优于CC和EMDR条件。但是, 在四周的随访中, VSDT被证明与EMDR等效且均优于CC。关于生动性, 数据也显示出支持在降低生动性方面VSDT等效于EMDR且两者均优于CC的假设。对简化版VSDT方案之间差异的进一步分析未发现这些条件之间存在差异。
结论: 尚不清楚VSDT如何产生积极作用。由于VSDT在降低厌恶记忆情绪化方面似乎是独特且有效的, 需要在临床样本中重复结果。

1. Introduction

Employing experimental studies using a sample of healthy participants is often standard practice when investigating a new treatment protocol using a rando mized controlled trial design (Spieth et al., 2016). Experimental models mimic abnormal processes in healthy individuals with the aim of translating this on to the processes observed in clinical samples. This also holds true for testing the applicability, safety, and efficacy of new methods for the treatment of post-traumatic stress disorder (PTSD). In the case of PTSD, it seems justified given the ubiquity of intrusive memories of negative experiences to study memory processes and mechanisms underlying intrusive memories in analogue samples (see Brewin, Gregory, Lipton, & Burgess, 2010; Holmes & Bourne, 2008). This is also the other way around; in the case of eye movement desensitization and reprocessing (EMDR) therapy, an evidence-based treatment for PTSD. Results in clinical samples have been replicated in experimental research (e.g. Van den Hout & Engelhard, 2012).

In EMDR therapy, patients recall an emotionally disturbing memory while at the same time engaging in another task, typically employing horizontal eye movements (EM), induced by following the fingers of the therapist who moves his hand back-and-forth at about 20 cm distance from the patient's eyes, or by following a moving light dot displayed on a light bar. The hypothesized working mechanism of EMDR is still being investigated, but most evidence is gained for the working memory account (De Jongh, Ten Broeke, Farrell, & Maxfield, 2020). The working memory account states that the working memory has a limited capacity. As a result of this, performing one task limits the performance of another task (Baddeley, 2012). When the working memory is 'loaded' with a traumatic memory, and at the same time a demanding task is performed – such as following the therapists' fast-moving fingers with the eyes – these tasks compete for working memory capacity. The two tasks simply cannot be performed at the same time, and as a consequence the emotional intensity of the memory is gradually lost and eventually reconsolidated in a less emotional form.

Visual Schema Displacement Therapy (VSDT) is a therapy that, like EMDR, also entails eye movements, but the eye movements are performed differently and VSDT therapy also contains several other elements. For example, in VSDT the therapist is standing in front of the patient and moves a watch from a point where the patient feels the most disturbance when bringing up an aversive memory, to a point where the patient most strongly feels the urge to laugh when recalling a happy memory or a person that makes the patient laugh. While doing that the therapist suddenly and loudly says

'Whoosh!'. Blinking and sighing are introduced after this. The procedure is repeated several times until the emotional intensity of the memory has subsided. Thus, while EMDR therapy and VSDT have elements in common, several components differ.

In 2019 a paper was published in which the results were reported of two experimental studies comparing VSDT with both an abbreviated form of EMDR therapy, and a non-active control condition among healthy participants suffering from disturbing memories (Matthijssen, van Beerschoten, de Jongh, Klugkist, & van den Hout, 2019). Although VSDT is a rather strange and unconventional therapy (e.g. it uses a watch that is turned around in a circle in front of the patient, patients have to blink and sigh deeply, and the therapist suddenly shouts 'Whoosh!'; see method section), it was found that VSDT outperformed not only the non-active control condition, but also EMDR therapy in the degrading of emotional disturbing memories. Furthermore, the results of the two subsequent experimental studies showed that VSDT and EMDR therapy were superior to a non-active control condition (CC) in terms of reducing vividness. Given that EMDR therapy is a well-established trauma therapy, and is recommended as a first-line treatment for posttraumatic stress disorder (PTSD; e.g. International Society for Traumatic Stress Studies, 2018; World Health Organization, 2013), the results warrant further study for a better understanding of these effects, and to identify the active components of VSDT.

The different components between EMDR therapy and VSDT may well explain why, until now, VSDT performed better in previous experimental studies (Matthijssen et al., 2019). One explanation is based on the working memory account (Baddeley, 2012), which is explained above. In VSDT patients are instructed to concentrate on a memory while conducting several different working memory taxing tasks (e.g. focusing on a watch, moving the eyes quickly, blinking, sighing, switching attention from one memory to another), which might be more taxing altogether than performing only eye movements. A second possible mechanism is counterconditioning. Patients need to switch from a traumatic memory to a positive memory or a memory of a person that makes the patient laugh, which creates a happy feeling that competes with the emotional disturbance of the negative memory. Counterconditioning has shown to be effective in several patient groups (e.g. Newall, Watson, Grant, & Richardson, 2017) and an element of effective treatment protocols such as COMET (e.g. Staring et al., 2016). Thirdly, the effect of surprise and destabilization could also be an essential ingredient. The procedure is somewhat unexpected for patients in that the therapist makes a sudden movement and shouts out loud, which can be quite surprising. Inducing surprise could have a destabilizing effect on memories that are held in mind (e.g. Sinclair & Barense, 2018). Related to this, there is the inducement of arousal. Anticipating a sudden loud sound and the subsequent 'Whoosh!' itself is likely to increase the level of arousal experienced by the patient. This has been found to be a potential active ingredient of effective (trauma) therapy (Foa, Riggs, & Gershuny, 1995; Jaycox, Foa, & Morral, 1998; Littel, Remijn, Tinga, Engelhard, & van den Hout, 2017) and could boost memory updating during reconsolidation (e.g. Anderson, Yamaguchi, Grabski, & Lacka, 2006). Lastly, another mechanism of action which could explain the effectiveness of VSDT is provided by the originators who suggest that the line of sight of both the traumatic and happy memory is essential for accessing the traumatic and happy memory. They reported that while recalling the traumatic event or the laughter moment patients often stared in a specific direction, individually different. This direction seems to individually determined (N. Speakman & E. Speakman, personal communication, 30 August 2016).

The purpose of the present study is twofold. One, the study aims to replicate earlier studies and two, the study aims to improve the understanding of the efficacy of VSDT. Therefore, the study is not only a replication study, but also a dismantling study in which VSDT, an abbreviated EMDR protocol, a non-active control condition (CC), and three altered VSDT protocols are compared. It is hypothesized that the standard VSDT-protocol would be more effective than any of the altered versions of the VSDT protocols and – given the previous findings – that the standard VSDT protocol would be equally or more effective than the abbreviated EMDR protocol, and more effective than the control condition in reducing emotionality and vividness of a disturbing memory.

2. Methods

2.1. Participants

Participants took part in this study in exchange for course credits or financial compensation. Of the 163 participants who responded in total, data from 144 participants (111 females, 33 males; M = 23.09 years, SD = 5.75) were included in the analyses. Nineteen participants were excluded for several reasons. Seven were excluded for not having a memory which caused sufficient emotional distress (a minimum score of 7 on a scale from 0 (*no distress*) to 10 (*maximum distress*) was required). Five participants were excluded because they used medication that might influence concentration, attention or mood/emotion and two were excluded due to psychological complaints, for which they required psychological treatment. Finally, another five participants were excluded after inclusion, because during the evaluation of all

the assessments, it appeared the protocol was not properly implemented or because the participant could not follow the protocol.

2.2. Materials

2.2.1. Subjective intensity of disturbance

Perceived intensity of disturbance or distress of an image or an emotional memory being recalled. The score is indexed on an 11-point Likert scale, the Subjective Units of Disturbance (SUD) scale, ranging from 0 ('none at all') to 10 ('maximum distress'). The SUD scale was introduced by Wolpe (1969) and incorporated in the standard EMDR protocol (Shapiro, 2018). In the present study, participants were requested to indicate the SUD score verbally to the research assistant (master student) at the start of and after each condition and at one and four-week follow-up.

2.2.2. Vividness

Perceived intensity of vividness of an image or emotional memory being recalled. The score is indexed on an 11-point Likert scale, ranging from 0 ('not vivid at all') to 10 ('very vivid'). Participants indicated this score verbally to the research assistant at the start of each condition, after each condition and at one and four-week follow-up.

2.3. Procedure

The study procedures were approved by the Faculty Ethics Review Board of the Faculty of Social and Behavioural Sciences (Utrecht University, The Netherlands) (FETC17-030). Recruitment took place on the university campus and on social media (Facebook, Instagram and the university research participation website). Individuals were asked whether they were interested in participating in an experiment concerning emotional memories. The experiment was performed in Dutch; therefore, admittance to the experiment was only permitted to Dutch-speaking individuals. The experiment consisted of a 30 minute face-to-face experiment and two 5-min follow-up phone calls, respectively, one and four weeks after the face-to-face experiment. The participants were phoned and asked to re-rate the SUD and vividness of the worst part of their memory. The experiment was carried out by three graduate students, who were trained in the abbreviated EMDR protocol by an EMDR Europe trainer and in VSDT by the originators of VSDT and the principal investigator. To ensure the procedure was carried out properly, fidelity checks were carried out by supervising video recordings of a pilot sample. Conditions were counterbalanced over the research assistants and participants were randomized in conditions by order of appointment. Once participants agreed to participate, an appointment was made. At the start of the experiment, participants were given an information letter which informed them about the procedure of the experiment, anonymity procedures, the right to stop the experiment without consequences whenever they wanted, and which included instructions to inform the research assistant if they were feeling too uncomfortable to recall the emotional memories. After this an informed consent was signed and a screening checklist was completed which included questions about age, education level, sex and exclusion criteria. Participants were excluded when they: had disrupting visual problems, which made it unable to perform the EMDR or VSDT procedure; reported problems with their concentration; were intoxicated by medication (influencing attention, concentration or mood); used drug or alcohol within 12 hours prior to participation which could still have an effect on the participants performance; suffered from extreme stress; had current psychiatric treatment for a disorder affecting concentration; or suffered from extreme fatigue. After completing the checklist, an emotional memory was selected. The participant selected a memory with sufficient emotional disturbance (at least seven out of ten), rated the emotionality of the memory and formulated a keyword describing the memory. Next, participants were subjected to one of the six conditions in which they were counterbalanced. The conditions all lasted 8 minutes. At the start of the procedure, the most disturbing part of the selected memory ('target') was recalled, rated on a scale of 0 to 10 on emotional disturbance and vividness. The most disturbing part was rerated after 8 minutes. The EMDR condition consisted of an abbreviated EMDR protocol (also see Matthijssen et al., 2019). Participants recalled a memory and were asked to select the most disturbing part of the memory (target) in the present time, which in EMDR therapy is always a still picture. Similar to the EMDR protocol they were asked to rate the Subjective Units of Disturbance (SUD; see Materials) of the target and to be aware of the location in their body where this disturbance was felt the most. Unlike the EMDR protocol, participants were also asked to rate the vividness of their target memory. Next, EMDR was performed until the end of the condition time. Both SUD and vividness of the most disturbing part of the memory were re-rated then.

The standard VSDT condition was similar to Matthijssen et al. (2019). Participants were asked to select a mental representation of a person or a memory of an event which made them laugh and to select a keyword for this memory/person. The research assistant held a watch with the clock face towards the participant and drew a circle with a diameter of about 1.5 m in a clockwise motion from the students' point of view. The participant

was instructed to indicate where in the circle the strongest urge to laugh was felt. This point (the 'laughter point') was indicated with the keyword and the participant indicated the urge to laugh at the laughter point on a scale of 0 ('no urge to laugh') to 10 ('maximum urge to laugh'). The same procedure was repeated for the emotional memory, where the participant indicated the 'trauma point' on the location in the circle where the most disturbance was felt which was subsequently rated from 0 to 10. The participant was instructed to keep his or her eyes focused on the watch and the assistant subsequently moved the watch quickly from the trauma point to the laughter point while saying out loud 'Whoosh!'. Next, the participant repeatedly blinked quickly, while being primed with the laughter point's keyword. After repeating the procedure three times participants squeezed the eyes tight twice and made two deep sighs. Participants re-rated how much the perceived emotionality of the target had declined compared to the previous rating. After 8 minutes, the alarm went off and SUD and vividness of the most disturbing part of the memory were re-rated. The altered conditions were the 'no whoosh' condition, 'fixed direction of view' and the 'no laughter point' condition. In the 'no whoosh' condition the 'whoosh' sound was left out of the procedure, thereby diminishing chances to induce a startle response (arousal). In the 'fixed direction of view' the assistant appointed two fixed spots for the trauma and laughter point, thereby leaving out the effect of point of view. In the 'no laughter point' condition the selection of the laughter memory/person and the laughter point was left out, thereby not explicitly inducing any positive feelings and testing the (added) effect of counterconditioning in the procedure. The watch was – in that condition – swiped 180 degrees from the trauma point.

The control condition consisted of eight minutes of doing nothing specifically. The instruction given to the participant, after selecting and rating the most disturbing part of the target memory on vividness and emotionality was to do nothing and just to relax. The further instruction given was that it did not matter what the participant would think about.

2.4. Design

The study had a 6 [Condition: EMDR, VSDT, VSDT-C (no laughter point), VSDT-N (no whoosh), VSDT-V (fixed direction of view), and Control Condition (CC)] by 4 (Time: pre, post, follow-up 1 and follow-up 2) between-subject repeated measures design, with Condition as the between-subjects factor and Time as the within-subjects factor. Dependent variables were the 'Subjective Units of Disturbance' (SUD; Emotionality) and 'vividness' of the memory. Since three assistants (graduate students) were performing the procedures, 'assistant' was also taken into account as a factor.

2.5. Data analysis

Although a power analysis is not necessary in Bayesian Statistics one was conducted as if null hypotheses testing would be conducted. It showed that to obtain a power of 0.8 with a probability of .05 and an estimated effect size or .25, 138 participants were needed. To obtain equal distribution over conditions and over research assistants, data from 144 participants were collected. All data were analysed using a Bayesian approach in which hypotheses were evaluated with Bayes factors. A Bayes factor (BF) is a measure of relative support for one hypothesis or model compared to one or multiple others. For example, the notation BF_{12} is used to express the support for H1 compared to H2. Note that H1 and H2 can be an informative hypothesis (e.g. using order constraints to express the expectation that certain mean scores are higher than others), a null hypothesis, or an unconstrained hypothesis. If BF_{12} is larger than one there is support for H1, and larger values represent more support. $BF_{12} < 1$ implies support for H2, with smaller values representing more support. BF values close to one indicate equal support for both hypotheses. Although the absence of strict cut-off scores is seen as a strength of Bayesian hypothesis testing and avoids arbitrary dichotomous decisions, there are some guidelines on how to interpret BF values. Usually, a BF of 3–10 is interpreted as moderate support for a hypothesis, and a BF > 10 as strong support. BF's of 1–3 are seen as anecdotal evidence, BF's 0–1 as no evidence.

2.5.1. Replication

For replication purposes, specific hypotheses resulting from previous studies on VSDT were tested, using confirmatory hypothesis testing in the statistical software BIEMS (Mulder, Hoijtink, & de Leeuw, 2012). BIEMS allows its user to formulate specific hypotheses with equality and inequality constraints and statistically compare the support the data show for each hypothesis. Summarizing, previous studies showed that VSDT was either superior or equal to EMDR in decreasing emotionality and vividness of disturbing memories over time, and VSDT and EMDR were both superior to a non-active control condition (Matthijssen et al., 2019). Therefore, three sets of hypotheses with condition as independent variable and difference scores of SUD and Vividness ratings (pre-post, pre-FU1, pre-FU2) as dependent variable were tested:

(1) VSDT > EMDR > Control Condition (CC)
(2) VSDT = EMDR > CC
(3) VSDT = EMDR = CC

The notation BF_h is used to express support for one of the specified hypothesis compared to the unconstrained hypothesis.

2.5.2. Main analyses

Because there were no specific a priori expectations regarding the effect of the different VSDT conditions, Bayesian repeated-measures analyses of variance (ANOVAs) were conducted in the statistical software JASP (v0.11.1; JASP Team, 2019) to compare overall differences between groups. Condition was used as between-subjects variable and the SUD or Vividness ratings represented the within-subjects variable time. Subsequently, Bayesian univariate ANOVAs were conducted with difference scores (pre-post, pre-fu1, pre-fu2) as dependent variable and group as independent variable to examine slope differences between the relevant time points. Default priors were used for all analyses (Rouder, Morey, Speckman, & Province, 2012). The notation BF_m is used to compare the quantification of support the data show for one model when compared to all other tested models. The tested models include main effects for Condition and Time, the interaction effect, and a combination of the aforementioned. BF_m was computed by dividing the posterior odds of the tested model by the average posterior odds of all other models. In posthoc analyses, the notation BF_{10} is used to express support for a single hypothesis (i.e. mean group scores were different) versus the null hypothesis. BF_{01} expresses support for the null hypothesis versus the tested hypothesis. JASP automatically corrects for multiple testing by fixing to 0.5 the prior probability that the null hypothesis holds across all comparisons (Westfall, Johnson, & Utts, 1997).

3. Results

3.1. Descriptive statistics

Data were obtained from 144 participants. At both follow-up measurements, 14 participants could not be reached leading to missing values. The missing follow-ups were roughly equally distributed between conditions (i.e. 1–4 per condition). The emotionality of the target memory was rated with an average SUD score of 7.98 (*SD* = 0.90) at baseline by the participants. The average baseline score of vividness was 8.17 (*SD* = 1.43). Examples of memories selected were: parents fighting during divorce, a suicide, a failed operation). In the VSDT conditions, participants rated their selected trauma point in the circle with an average score of 7.93 (*SD* = 0.97), and their laughter point 7.99 (*SD* = 0.83). The VSDT procedure of swiping from the trauma point to the laughter point, combined with the therapist saying 'Whoosh!', and the participant blinking and sighing was repeated approximately ten times in all VSDT conditions (*M*= 9.88, *SD* = 2.98) until the session time was over. In the EMDR condition, an average of 4.17 sets of eye-movements (*SD* = 1.70) were performed. In nine cases (VSDT = 1; VSDT-C = 3; VSDT-V = 5) the SUD score of the disturbing memory reached zero before the session time (i.e. 8 minutes) was over.

3.2. Randomization check

Bayesian ANOVAs showed convincing support for the null model with no groups differences at baseline for both the SUD (BF_m = 21.73) and Vividness (BF_m = 8.38). The null model with no group differences in age (Bayesian ANOVA; BF_m = 12.67) and gender (Bayesian contingency table; BF_m = 241.13) was also strongly supported.

3.3. Replication

Quantified support for all hypotheses is presented in Table 1. Hypothesis 1 (H1) states difference scores (SUD or vividness) between time points are larger for participants in the VSDT condition when compared to EMDR, and difference scores in the EMDR condition are larger than the control condition (CC). Hypothesis 2 (H2) states the VSDT condition equals EMDR, and both are larger in effect than the CC. Hypothesis 3 (H3) states difference scores for all conditions are equal. For the descriptive statistics of all difference scores, see Tables 2 and 3 for SUD and vividness ratings, respectively.

3.3.1. Emotionality

From pre to post the Bayes factors indicate moderate support for H1 in comparison with H3 and anecdotal compared to H2. From pre to follow-up 1 (1 week), H1 shows moderate support compared to H2 and H3. From pre to follow-up 2 (4 weeks) H1 receives anecdotal support compared to H2 and H3. Note that from pre to post H2 also receives moderate support compared to H3 and from pre to follow-up 2 anecdotal support compared to H3.

3.3.2. Vividness

From pre to post, pre to follow-up 1 and pre to follow-up 2 H1 receives moderate support compared to H3. Compared to H2 there is anecdotal support on all time points (pre to post, pre to follow-up 1, pre to follow-up 2).

3.4. Main analyses

3.4.1. Emotionality

The Bayesian repeated-measures ANOVA comparing emotionality (SUD scores) over time between groups

Table 1. Bayes factors for all tested replication hypotheses compared to the unconstrained hypothesis, specified per dependent variable, time point, condition and hypothesis.

DV	Time	Hypothesis	BF_h
SUD	Pre-post	H1. VSDT > EMDR > CC	3.74
		H2. VSDT = EMDR > CC	1.81
		H3. VSDT = EMDR = CC	0.53
	Pre-FU1	H1. VSDT > EMDR > CC	2.34
		H2. VSDT = EMDR > CC	0.74
		H3. VSDT = EMDR = CC	0.54
	Pre-FU2	H1. VSDT > EMDR > CC	2.94
		H2. VSDT = EMDR > CC	2.17
		H3. VSDT = EMDR = CC	1.21
Vividness	Pre-post	H1. VSDT > EMDR > CC	2.96
		H2. VSDT = EMDR > CC	2.71
		H3. VSDT = EMDR = CC	0.69
	Pre-FU1	H1. VSDT > EMDR > CC	3.10
		H2. VSDT = EMDR > CC	2.26
		H3. VSDT = EMDR = CC	0.90
	Pre-FU2	H1. VSDT > EMDR > CC	3.50
		H2. VSDT = EMDR > CC	2.30
		H3. VSDT = EMDR = CC	0.70

DV = dependent variable; SUD = subjective unit of disturbance; FU1 = follow-up after 1 week; FU2 = follow-up after 4 weeks; CC = control condition.

shows largest support for an interaction effect between Condition and Time, BF_m = 23.85, when compared to all other models (all BFs <1). To further specify this interaction, separate Bayesian Univariate ANOVAs were conducted with Condition as independent variable and difference scores (pre to post, pre to follow-up 1, pre to follow-up 2) as dependent variables. For a graphical overview of all SUD ratings, see Figure 1. For descriptive statistics of the difference scores between relevant time points, see Table 2.

3.4.1.1. Pre-post. The analysis showed convincing support for a varying decrease in SUD scores between groups from pre to post, BF_m = 82.60. Posthoc analyses indicate a strong support for larger decreases for all VSDT conditions compared to the CC (VSDT: BF_{10} = 10.28; VSDT-C: BF_{10} = 39.23; VSDT-N: BF_{10} = 210.63; VSDT-V: BF_{10} = 318.83), and anecdotal to moderate support for larger decreases for all three altered VSDT protocols compared to EMDR (VSDT-C: BF_{10} = 1.48; VSDT-N: BF_{10} = 3.63; VSDT-V: BF_{10} = 5.57). All other mutual comparisons received no support (BF_{10} < 1). For an overview of all SUD difference scores, see Table 2.

3.4.1.2. Pre- follow-up 1. Differences in SUD reduction between groups from pre to follow-up 1 was strongly supported by the Bayesian ANOVA, BF_m = 10.57. Posthoc analyses show varying degrees of support for larger decreases in all VSDT conditions when compared to the CC (VSDT: BF_{10} = 1.58; VSDT-C: BF_{10} = 43.46; VSDT-N: BF_{10} = 5.63; VSDT-V: BF_{10} = 3.19), as well as when compared to the EMDR condition (VSDT: BF_{10} = 1.74; VSDT-C: BF_{10} = 36.93; VSDT-N: BF_{10} = 5.44; VSDT-V: BF_{10} = 3.25). All other mutual comparisons received no support (BF_{10} < 1).

3.4.1.3. Pre- follow-up 2. The Bayesian ANOVA for differing decreases in SUD scores did not provide support for differences between groups. Instead, the null model was favoured, but only anecdotal (BF_m = 2.98). Posthoc analyses show inconclusive to moderate evidence for larger reductions in SUD scores between the VSDT conditions compared to the CC (VSDT: BF_{10} = 1.00; VSDT-C: BF_{10} = 1.06; VSDT-N: BF_{10} = 4.91; VSDT-V: BF_{10} = 2.45). All other mutual comparisons received no support (BF_{10} < 1).

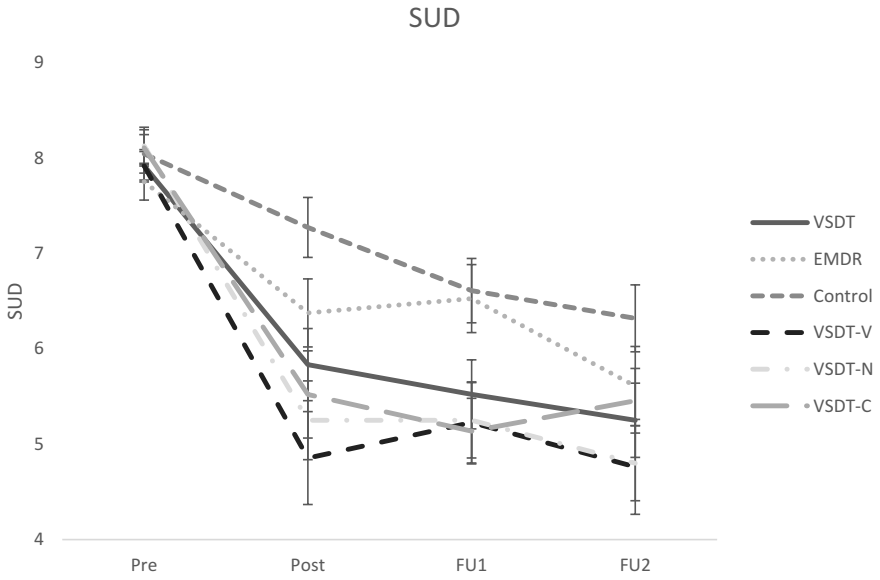

Figure 1. Mean (SE) SUD scores for all time points specified per condition. SUD = subjective unit of disturbance; FU1 = follow-up after 1 week; FU2 = follow-up after 4 weeks; VSDT-C = VSDT without laughter point; VSDT-N = VSDT with no whoosh; VSDT-V = VSDT with a fixed direction of view.

Table 2. Mean (SD) decreases in SUD ratings between different time points.

	Pre-Post	*d*	Pre-FU1	*d*	Pre-FU2	*d*
CC	0.77 (1.01)	0.76	1.48 (1.23)	1.20	1.77 (1.47)	1.21
EMDR	1.38 (1.87)	0.73	1.38 (1.34)	1.03	2.22 (1.86)	1.19
VSDT	2.08 (1.86)	1.12	2.43 (1.85)	1.31	2.70 (2.02)	1.34
VSDT-C	2.58 (2.24)	1.15	3.07 (1.66)	1.85	2.68 (1.87)	1.43
VSDT-N	2.88 (2.21)	1.30	2.88 (2.03)	1.42	3.23 (2.00)	1.62
VSDT-V	3.06 (2.35)	1.31	2.73 (2.07)	1.32	3.10 (2.21)	1.40

SUD = subjective unit of disturbance; FU1 = follow-up after 1 week; FU2 = follow-up after 4 weeks; CC = control condition; VSDT-C = VSDT without laughter point; VSDT-N = VSDT with no whoosh; VSDT-V = VSDT with a fixed direction of view; *d* = Cohen's *d*.

3.4.2. Vividness

The Bayesian repeated-measures ANOVA comparing vividness scores over time between groups shows the largest support for a main effect of Condition, a main effect of Time and no interaction effect (BF_m = 5.33). A model with only a main effect of Time is also supported (BF_m = 1.88), whereas a model including the interaction effect receives no relative support compared to all other models (BF_m = 0.49). For a graphic overview of all vividness ratings, see Figure 2. For descriptive statistics of the difference scores between relevant time points, see Table 3.

3.4.2.1. Pre-post. The Bayesian univariate ANOVA comparing decreases in vividness scores from pre to post between conditions shows no support for differences between groups. The null model was favoured instead, BF_m = 2.03. Post-hoc analyses show varying degrees of support for larger differences in most conditions compared to the CC (EMDR: BF_{10} = 1.99; VSDT: BF_{10} = 1.46; VSDT-N: BF_{10} = 9.46; VSDT-V: BF_{10} = 3.63). All other mutual comparisons receive no support (BF_{10} < 1).

3.4.2.2. Pre-FU1. The analysis showed roughly equal support for the model including differences between groups (BF_m = 1.05) when compared to the null model (BF_m = 0.95). Posthoc analyses show moderate support for larger decreases in vividness ratings when comparing the abbreviated VSDT protocols to the CC (VSDT-C: BF_{10} = 3.16; VSDT-N: BF_{10} = 4.45; VSDT-V: BF_{10} = 5.19). Support for differences between VSDT-N and VSDT-V compared to EMDR is inconclusive, with BFs close to 1 (VSDT-N: BF_{10} = 1.56; VSDT-V: BF_{10} = 1.23). All other mutual comparisons receive no support (BF_{10} < 1).

3.4.2.3. Pre-FU2. The presence of differences in vividness reductions between groups was not supported by the Bayesian ANOVA, BF_m = 1.93. In posthoc analyses, moderate support is found for larger vividness decreases for all VSDT conditions when compared to the CC (VSDT: BF_{10} = 2.52; VSDT-C: BF_{10} = 8.33; VSDT-N: BF_{10} = 4.73; VSDT-V: BF_{10} = 6.56). All other mutual comparisons received no support (BF_{10} < 1).

4. Discussion

The purpose of the present study was twofold. One was to replicate the earlier study of Matthijssen et al. (2019) and the second was to examine possible working mechanisms of VSDT. The present findings replicate previous findings (Matthijssen et al., 2019) in that VSDT reduced emotionality and vividness of disturbing memories, not only immediately after the intervention, but also at follow up after one and four weeks. From pre to post, 1 week follow-up and four week follow-up, the results showed most support for

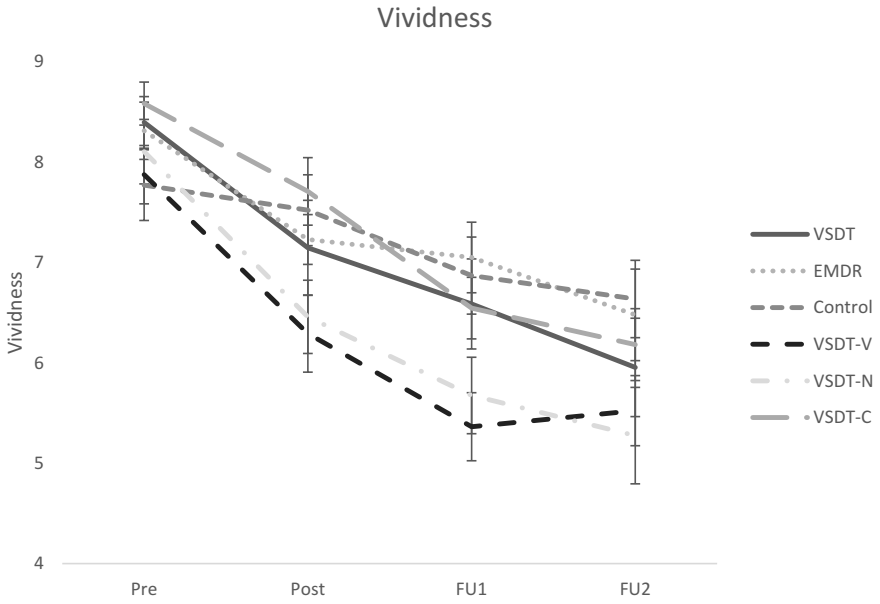

Figure 2. Mean (SE) Vividness scores for all time points specified per condition. FU1 = follow-up after 1 week; FU2 = follow-up after 4 weeks; VSDT-C = VSDT without laughter point; VSDT-N = VSDT with no whoosh; VSDT-V = VSDT with a fixed direction of view.

Table 3. Mean (SD) decreases in Vividness ratings between different time points.

	Pre-Post	*d*	Pre-FU1	*d*	Pre-FU2	*d*
CC	0.25 (1.16)	0.22	0.87 (1.80)	0.48	1.00 (1.45)	0.69
EMDR	1.08 (1.44)	0.75	1.38 (1.49)	0.92	1.80 (2.39)	0.76
VSDT	1.25 (2.13)	0.59	1.83 (2.15)	0.85	2.34 (2.26)	1.03
VSDT-C	0.88 (1.39)	0.63	2.07 (1.43)	1.44	2.50 (1.89)	1.32
VSDT-N	1.65 (1.96)	0.84	2.40 (1.99)	1.21	2.80 (2.76)	1.02
VSDT-V	1.58 (2.30)	0.69	2.41 (1.99)	1.21	2.43 (1.83)	1.33

FU1 = follow-up after 1 week; FU2 = follow-up after 4 weeks; CC = control condition; VSDT-C = VSDT without laughter point; VSDT-N = VSDT with no whoosh; VSDT-V = VSDT with a fixed direction of view; *d* = Cohen's *d*.

superiority of VSDT over EMDR and the control condition, and superiority of EMDR over the control condition in reducing emotionality of aversive memories in healthy participants. However, there is also some support for equality in effect of EMDR and VSDT, both outperforming the control condition, and the difference between the model where VSDT outperformed both is only slightly stronger than the model in which VSDT and EMDR both outperformed the control condition. Also, the results of the study show that differences in effect at four weeks follow up were smaller than at post and one week follow up. Results of vividness show a same pattern and roughly replicates findings of Matthijssen et al. (2019). VSDT outperformed both EMDR and the control condition at any time point, but the difference with the model in which EMDR was equally effective to VSDT, and both were outperforming the control condition, was small.

The second goal was unravelling the working mechanism of VSDT. The study contained a set of manipulated VSDT conditions in order to examine the effect of the different postulated hypotheses for working mechanisms of VSDT. Three different working mechanisms were investigated. The results showed that none of the protocol variations proved to be superior over the other and none was less effective than the original VSDT protocol. Because the three different variants of the VSDT used in this experiment showed equivalent results, it remains unclear how the effects of VSDT can be explained. Apparently, arousal, line of sight and counterconditioning do not seem to be critical in its effect. Curiously, leaving out each of these original elements considered to be a crucial part of the procedure (i.e. choosing the exact location of the trauma/laughter point, arousal induction, inducing a positive feeling after eliciting a traumatic memory), the VSDT method performed at least as well, and the original version even slightly better, as EMDR, one of the most effective methods in the field of trauma treatment. The question is therefore what could cause the memories of people who undergo VSDT to lose their vividness and emotionality? In other words, what remains that makes this intervention so effective? One of the possible explanations is that the combination of different mechanisms of action could be responsible for the effect, and that leaving out one of these would still make the procedure a strong intervention. Another explanation is that the mechanism that actually makes the procedure effective was not studied in the current study. The effect of suggestion is one of such explanations. In the VSDT procedure, the researcher or the therapist clearly asks how much emotionality has decreased every time one checks the remaining emotionality of the selected memory. The question is whether such a suggestive question is capable of eliciting such a powerful effect even after four weeks. Perhaps a better explanation might be the blinking of the eyes. People are asked to blink with their eyes as quickly as possible. It has been observed that during blinking neuronal activity in the parietal and prefrontal cortex is actively suppressed (Bristow, Haynes, Sylvester, Frith, & Rees, 2005), but how this could affect the reconsolidation of memories is unknown. Besides that, also sighing, a procedure patients are instructed to intentionally do, could play an essential role. It was mentioned by several patients who received treatment with VSDT that the sighing element made them feel the distress disappearing. A future study in which this behavioural instruction is further investigated will have to determine the value of it.

Regarding the limitations of the present study, it should be clear that this study tested the efficacy of abbreviated versions of therapeutic procedures applied to previously selected memories of healthy participants. Accordingly, simply because VSDT seems to be effective in reducing emotionality of aversive memories it cannot be concluded that it is an effective therapy for patients suffering from mental health conditions such as anxiety disorders or those suffering from posttraumatic stress disorder (PTSD). Hence, at least the current, but also the previous studies on VSDT warrant a randomized study among patients with an established condition like PTSD. Furthermore, there was a gender bias, with more females being included than males, however gender was equally distributed between conditions and there is no a priori reason to assume that male participants would react differently to the intervention compared to females.

In conclusion, the present results further support the notion that VSDT is capable of reducing the emotionality and vividness of aversive memories. Although it remains unclear how exactly VSDT yields its positive effects, because VSDT is remarkable effective, replication of the present findings in a clinical sample is strongly needed.

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Author statements

SM designed the research and methodology. SM and TB supervised collecting the data, SM and AdJ trained the

assistants and supervised treatment fidelity. TB and IK analysed the data. SM, TB and AdJ wrote the original draft paper, SM, TB, AdJ and MvH reviewed and edited. SM, TB, MvH, IK and AdJ approved the final manuscript.

Data availability

Data available on request due to privacy/ethical restrictions. The data that support the findings of this study are available on request from the corresponding author, SM. The data are not publicly available due to their containing information that could compromise the privacy of research participants. Furthermore, participants were not asked to give consent of saving their data in a public data repository.

Disclosure statement

Ad de Jongh receives income from published books on EMDR therapy and for training postdoctoral professionals in this method. None of the other authors have a conflict of interest in this study.

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