RESEARCH ARTICLE

Dose response and working memory limit in an eye movement desensitisation and reprocessing prospective case series [version 1; peer review: 1 approved with reservations, 1 not approved]

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Abstract

Background: Eye movement desensitization and reprocessing (EMDR) is a psychological therapy for post-traumatic stress disorder, or any disorder where the patient reports distressing imagery. We report here a prospective case series to test the prediction that the average number of distress images tends to seven.

Methods: Patients in a sexual health clinic were offered EMDR treatment. In total, 130 were entered and 50 completed treatment. All distressing images to all bad life events and anxieties reported were treated. Images that caused high distress or stopped progressing were usually decomposed until progress resumed.

Results: The median number of images per patient was seven. This required three treatment sessions in a total of five appointments, on average. This result was replicated twice in separate retrospective case series.

Conclusion: We propose that EMDR works by unloading an overloaded memory buffer. If this bandwidth is liberated by treatment, this permits the cognitive and emotional change observed in EMDR treatment. The tendency to seven may signal involvement of the working memory limit. This approach enables clinical decision making and gives common ground with other psychotherapy methods.

Keywords

Eye Movement Desensitization and Reprocessing, Dose dependency, Working memory, Clinical decisions, Seven

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Introduction

Eye movement desensitisation and reprocessing (EMDR) is a psychological therapy, originally for post traumatic distress disorder (PTSD), but generalizing to any patient who reports distressing imagery^{1,2}. The image is specified with negative cognitions and distressing physical sensations. The patient is then taken through a procedure based on series of sets of 25 eye movements with the guidance of the therapist. The patient will report the image is fading or changing in some way, the negative cognitions improving and the distress reducing. The cognitions and distress improve without necessarily being addressed by direct verbal methods. Other methods of sensory stimulation have the same effect. There is no explanation of how this procedure works. An explanation is required to inform clinical judgements and to permit the design of more accurate trials.

On the basis of clinical experience, we hypothesize that EMDR is superior to cognitive behavioural therapy (CBT) because it is faster. If a treatment can be accelerated with equal benefit, then more patients could be treated within a given budget. One premise of a controlled trial is that both control and experimental group receive equivalent treatment, except for the variable being investigated. In psychological trials, this requires that both groups should receive an equal treatment time. The published trials do not always balance the number of sessions or treatment time. Consider a trial in which EMDR is compared to CBT over ten weekly appointments of one hour. CBT includes homework, such as listening to audio files of the trauma event, or real life exposure when practical. Assume this homework takes one hour per day, happens each of the six days the patient does not attend an appointment and is performed with perfect compliance. Therefore, EMDR clients are getting 10 hours of treatment, while CBT clients are getting 70 hours. If the result shows equal results for each therapy, then we should conclude that EMDR is seven times faster than CBT and avoids the problem of homework compliance. Homework compliance is associated with improvement in CBT for PTSD³. Some trials address this problem⁴ and some do not (e.g 5). For a recent review see 6.

To prove EMDR is faster than CBT, patients in a controlled trial should receive an equal number of sessions. Since we could not do a trial in our circumstances, we investigated if the number of EMDR sessions required is limited by the number of distress images. In our clinic, eye movement therapy has been used since 1991 and was based on Shapiro's original reports^{1,2,7}. Clinical experience showed that EMDR treatment required treatment of around seven images. We hypothesised that the average number of distress images in an EMDR series would be attracted to seven, plus or minus two, images. A retrospective investigation of 400 case files discovered an average of 5.5 distress images⁸. To investigate this, we counted the distress images in a prospective series and collected demographic and evaluation data.

Methods

Participants

This study was approved by the Plymouth Local Ethics Committee (number, 1743). All patients gave written informed consent to enter the study. The original analysis plan, using non parametric, required 50 patients to complete. However, this plan was

superseded by the analysis described below. The patients were recruited between September 2001 and March 2007.

Patients in the Genitourinary Medicine clinic (GUM) were offered EMDR whenever distressing images were reported. No a priori judgements of single trauma event, multiple events or complexity of case were made. Patients were recruited according to the following inclusion criteria:

1. They reported a defined traumatic event or history;
2. English was their first language;
3. They were not receiving any concurrent psychological therapy or counselling. If they were, they were willing to suspend this during EMDR treatment;
4. They were not suffering any concurrent bad life event or illness;

Patients were disqualified from the study under the following circumstances:

1. They suffered a bad life event during treatment. For example, a serious illness suffered by themselves or family member;
2. Any increase in medication. If medication levels were stable, or decreasing, they were retained;
3. They requested to leave.

A disqualifying event was any active event. For example, a patient with stable diabetes was entered, but a patient who was diagnosed with diabetes the week after entry was removed from the study. Removed patients continued with EMDR or other treatment or help as required. Most had a history of sexual health problems that brought them into GUM in the first place. Some patients were the marital or sexual partners of GUM patients, but without primary sexual health concerns. The following information was collected for each patient: sex, age, marital status, employment status, initially presented trauma, how long since that trauma, any significant mental health or addiction issues, presence of panics, total contact hours and number of EMDR treatment sessions.

Measures

EMDR treatment reduces clarity and perception of distress images and consequently the distress score reduces.

We recorded the number of distress images reduced to a low distress score that remained stable on retesting in subsequent treatment sessions (designated "F"). Distress was measured with the Subjective Units of Disturbance score from zero to ten and the end point was taken as zero, one or two. The Foa PTSD questionnaire was used to measure initial severity⁹.

Treatment progress was measured with three questionnaires: the Impact of Events Revised, (IOE-R), the General Health Questionnaire (GHQ-12), and the Posttraumatic Cognitions Inventory (PTCI). The Impact of Events revised version was used, which matches the later definition of PTSD^{10,11}. A drawback of the IOE-R is that it only refers to one bad event. We intended to

deal with all reported events. Patients who reported more than one were asked to consider the initial event. The GHQ-12 is a psychiatric screen¹². The PTCI measures cognitive symptoms and was chosen to exclude imagery or physiological arousal¹³.

Therapeutic procedure

All patients received EMDR from the clinical psychologist (AH). This psychologist had 10 years' experience with EMDR before the study began and was level one and level two trained. EMDR, as used here, was based on the original protocol¹ and resembles the "eye movement desensitization" protocol that can be found in Chapter 9 of the third edition of Shapiro's manual⁷. However, it does not include all eight stages later described by Shapiro, elsewhere in this book.

Body scan, re-evaluation, debriefing and closure were employed when required. Three parts of the eight-phase EMDR procedure were omitted. The safe place procedure and the "cognitive interleave" were never required. If distress stopped progress, the image was reassessed or decomposed to smaller components. At a certain point, the treatment would start reducing distress again. If the patient was distressed at the end of the session, a brief relaxation was taught. The patients reported cognitive changes during the procedure and the PTCI was intended to measure this. The "positive cognitions" procedure was not used. Here, patients report what positive belief they would like concerning themselves and rate it on a one to seven validity scale. This is then used for "installation" of positive cognitions. The therapist dropped this because switching from discussing the bad event to discussing what the patient might think in an ideal world was confusing and distressing for the patient¹⁴. It became redundant since patients would report positive thoughts when treatment continued through the series of distress images.

Treatment sessions began by revisiting relevant issues. All distressing images collected or treated in previous sessions were reassessed. The EMDR was then started. The starting rule was expressed as follows: "We will start on the highest scoring image, because that probably makes the procedure shorter in the long run. If you are not ready to start there, please choose somewhere else to start". The patient was asked to attend to the chosen image and nod when ready. He or she was then taken through sets of 25 eye movements. A stick 70 cm long, with a coin at one end as a visual target was used to guide the eye movements. If the patient reported a problem with eye movements another method of sensory stimulation was used. This was auditory or tactile stimulation using the (www.neurotekcorp.com). This change was judged as a clinical decision and no attempt made to balance it between patients. After each set, the patient was reassessed. When a new image was reported, it was treated or recorded for later treatment.

If the patient became distressed, treatment was continued until the distress reduced. If the distress did not reduce after four sets of eye movements the image was changed in some way. The first move was to enquire if there was a more distressing image, negative thought, emotion or physical sensation or pain. Another option was to move to an alternative image that did reduce

and return to the difficult image later. The best option was to decompose the target image in some way. One method was to reduce that part of the timeline the patient was focusing on. For example, the event would be divided up into smaller stages of the sequence. The second was to divide up into sensory modalities. For example, a sexual assault could be divided up into the physical pain images, the sound of the assailant's voice and the feeling of the weight of their body. Each sensory image was treated individually and included in the "F" count. This course of action generally resulted in effective treatment.

All reported distress images were treated. This included any anxiety or distress trigger that could be elicited as an image and scored, not just the initial presented event. EMDR targets also included images of future events ("flashforwards"). Other images were imagined or symbolic representations of events where the patient had been absent or unconscious. Some images were general (semantic) memories, not episodic. For example, a repeated act of child abuse would be reported as one image, not individual episodes with time tags. Such semantic images might decompose to episodes with treatment, but could be treated without this happening. One strategy to use such semantic memories for desensitization was to ask the patient to imagine the face of the assailant or abuser, then describe and score bad emotions.

Research procedure

The patient was briefed on the procedure. Any problems or limitations of EMDR specific to that patient were discussed. The patient was informed of the seven image average to achieve informed consent, but it was emphasized that this was an average. The patient could report more or less than seven. It was made clear that treatment would continue until all reported distressing images, of whatever origin, were treated. The initial assessment explicitly included listing all trauma life events and distress triggers. The patient gave signed consent to the project as required by the local ethical committee.

Each patient received the IoE-R, GHQ12 and PTCI questionnaires on each treatment appointment. On the first treatment appointment, the Foa questionnaire was also given. Questionnaires were completed on arrival, before the appointment began.

In the first session, the EMDR procedure began at an agreed starting point. In the second and subsequent appointments, the patient was reassessed for each image collected in previous sessions. The patient visualised the image, reported if that was impossible, difficult or easy, reported the distress score and then anything else relevant. Treatment then continued, as described above. Treatment sessions continued until all images were desensitised to a distress score of zero, one or two. The number of images desensitized was recorded on each occasion ("F"). The value of F recorded in the first treatment session was zero.

It was not expected that EMDR treatment would be sufficient for all the needs of all the patients or that all patients would complete treatment. Patients in this clinic have a high drop-out rate from medical treatment. We investigated if there were any

systematic differences between completers and dropouts, using the data collected. A record was kept of all patient outcomes or destinations.

Postal follow-up

Six months after treatment ended, all 50 patients who completed treatment were contacted by mail. The letter contained a list of recorded distress images and the three questionnaires. The patient was requested to score all items and return by stamped addressed envelope. In total 31/50 scores were returned.

Two informal replications

Another retrospective count of distress images was included in an audit of appointment attendance. This was a “file drawer” sample, to replicate this result. In total 200 cases were audited from GUM, of which 167 (83%) were EMDR cases. These cases were collected between November 2010 and June 2012.

A second retrospective series was collected at GUM during a period when it appeared that some severe cases were showing high numbers of images. The idea was to test the resilience of the hypothesis that the average would tend to seven. These cases were collected between November 2015 and July 2017.

These two series were taken from routine audit databases for which ethical permission is not required by local rules. The three case series reported were all separate, with no overlap of cases.

Data analysis

Data was analysed using R version 3.4.1. R code used in the analysis can be found in [Dataset 1¹⁵](#).

Dataset 1. R program files¹⁶, requiring R.app or RStudio.app (on Mac) or equivalent to run (cran.r-project.org)

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The scripts were run in R version 3.4.1 (2017-06-30). The first three (GHQ12WilcoxonOnly.R, ImpactESRWilcoxonOnly.R, PTCIWilcoxonOnly.R) calculate the scores shown in [Table 2–Table 4](#). The last (RunningMeans&PlotFig1to4.R) takes the “F” value files and calculates the bootstrapping values as described above and plots [Figure 1–Figure 4](#).

Results

Patients

To acquire 50 patients who finished treatment, it was necessary to recruit 130 patients, giving a fail to complete number of 80 (62%). There were 104 females and 26 males. The average age was 33 years. A total of 85 (65%) were employed, 25 unemployed, 14 students and 6 retired; 67 (51%) were single, 54 (41%) were married or co-habiting, the 9 remaining were divorced. They were all white British, except one Irish female and one white South African male. These patients were entered into the study between September 2001 and March 2007.

The initially reported trauma event occurred at a mean of 12 years previously. Forty (30%) patients reported medical problems,

including 3 stable diabetics. Thirty-nine (30%) reported another mental health or addiction problem, of which 32 reported depression and 12 reported panics; Twenty-four required medication for that problem. Initially presented trauma events, by sex, are shown in [Table 1](#) for all 130 patients. Most patients were sexually assaulted females. No distinction was made between different types of childhood abuse. Sexual misadventure means any such trouble that was not sexual assault. See [Dataset 2¹⁷](#).

Dataset 2. Demographic data for participants

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The 50 patients who completed treatment required a mean of 3.8 treatment sessions (mode = 3.0). A treatment session was one hour long. The mean number of contact hours required per patient was 5.04 (mode = 4.0). This includes assessment, treatment sessions, follow-up and time required for other matters.

Psychometric test scores

Convincing improvement in score results are required to validate the results below. 50 cases completed treatment, resulting in 49 complete before and after pairs. There were 31 complete follow-up scores, which were paired with the respective after scores. Good score decreases were observed for all three questionnaires, all of which had low probability values. All score changes and statistics are shown on [Table 2–Table 4](#). Follow-up gave stable values for the IoE-R scale and PTCI. Note the PTCI decreased without any items concerning imagery. However, the GHQ-12 follow-up scores increased, with statistical significance. Raw data is available in [Dataset 3¹⁸](#) with analysis programmes in [Dataset 1¹⁵](#).

Table 1. Initially presented trauma of eye movement desensitisation and reprocessing patients distributed by sex (n=130).

Event	Male	Female
Rape	7	46
Assault	2	2
Child Abuse	9	30
Bereavement	1	5
Combat	2	0
Sexual misadventure	2	2
Marital abuse	1	7
School bullying	1	0
Medical misadventure	0	9
Occupational Hazard	1	1
Accident	0	2
TOTAL	26	104

Dataset 3. The before, after and follow-up scores for the General Health Questionnaire (GHQ-12), the Impact of Events scale (IoE-R) and the Post Traumatic Cognitions Inventory (PTCI)

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Average value of F

The hypothesis was that the average number of distress images would approach seven. The frequency distribution of F is shown in Table 5 (Dataset 4¹⁹). The mean value for the 50 patients is 7.6 images. The median was seven and the mode was seven. Figure 1 shows the case series of the 50 completed cases

as a “law of large numbers” graph. This is a plot of progressively calculated running means on the Y axis, ascending the case series on the X axis. This shows that after about 20 cases, the mean number of distress images is between seven and eight, close to the hypothesised value. Since the data are not a random sample, we cannot assume a conventional statistical model to test this result. However, having shown the average tends to seven, we need a way of assessing and testing variation in this value.

Dataset 4. “F” values for the initial prospective 50 cases and then the two retrospective series of 167 and 106 cases

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Table 2. Questionnaire score changes: Impact of Event Score-Revised.

First	Last	FU	Z	W	P	C
51.5	6.0		5.9	1126	5.6×10^{-9}	0.98
	6.0	7.0	-0.4	184	1.00	0.49

Scores summarized as medians, for First, Last and Follow-up (FU). There were 48 pairs First v. Last and 31 pairs for Last v. Follow-up. Z = Z score; number of standard deviations difference. W = Wilcoxon signed-rank test value. P = Probability median scores are different by chance; values are multiplied by 2, to adjust for multiple comparison, by Bonferroni correction. C = Common language effect size²⁰; this is the probability that any initial score will be different from any subsequent score¹⁵.

Table 3. Questionnaire score changes: Post Traumatic Cognitions Inventory.

First	Last	FU	Z	W	P	C
147	61		5.8	1078	8.8×10^{-9}	0.91
	61	64	-0.7	197	0.94	0.44

Scores summarized as medians, for First, Last and Follow-up (FU). There were 48 pairs First v. Last and 31 pairs for Last v.

Follow-up. Z = Z score; number of standard deviations difference. W = Wilcoxon signed-rank test value. P = Probability median scores are different by chance; values are multiplied by 2, to adjust for multiple comparison, by Bonferroni correction.

C = Common language effect size²⁰; this is the probability that any initial score will be different from any subsequent score¹⁵.

Table 4. Questionnaire score changes: General Health Questionnaire-12.

First	Last	FU	Z	W	P	C
17	5.0		5.7	988.5	1.7×10^{-8}	0.93
	5.0	10.0	-3.3	59.5	0.002	0.31

Scores summarized as medians, for First, Last and Follow-up (FU). There were 48 pairs First v. Last and 31 pairs for Last v. Follow-up. Z = Z score; number of standard deviations difference.

W = Wilcoxon signed-rank test value. P = Probability median scores are different by chance; values are multiplied by 2, to adjust for multiple comparison, by Bonferroni correction. C = Common language effect size²⁰; this is the probability that any initial score will be different from any subsequent score¹⁵.

We can investigate this with bootstrapping²¹, which simulates repeating the study many times to give an empirical distribution for F. In this case, a sample of 50 cases was taken from the data, at random, with replacement of each value, so there is always 50 cases to sample from. The sampling was repeated 1000 times. Each sample of 50 generates a mean value and consequently confidence intervals can be found for true mean of F. An R program was written to achieve this^{16,22,23}. We used percentile confidence intervals, so the 95% boundaries take the value of the 25th lowest and highest means from the 1000 iterations. This program will give slightly different results each run, but example values are 6.68 and 8.90, which accommodate the hypothesised value and suggests that in groups of 50 patients we would expect the average number of distress images to be between six and nine. The bootstrap confidence interval is skewed right, reflecting that a small number of cases with a high number of distress images have a big influence on the mean in this relatively small group size. The bootstrap values and graphs are in Dataset 2¹⁷ (RunningMeans&PlotFig1to4.R). The intention to treat value of “F” was determined from the 99 cases who completed at least two sessions and recorded at least one F value. This includes the

Table 5. Distribution of final F values.

F Value	Frequency	Percent	Cumulative %
1	1	2.0	2.0
3	1	2	2.0
4	7	14	18
5	2	4	22
6	9	18	40
7	11	22	62
8	5	10	72
9	4	8	88
10	4	8	88
11	2	4	92
13	2	4	96
22	1	2	98
23	1	2	100

F = number of distressing images, treated per patient.
Mean = 7.62; Mode = 7; Median = 7.

Figure 1. Graph of Running Mean or “Law of Large Numbers” plot, showing mean number of images tending to the final mean value of 7.68. For 50 cases in prospective series. Dotted lines show 95% percentile bootstrap confidence intervals.

50 cases discussed above. The mean was 6.5 and the mode and median both 6.0.

Two retrospective replications

The first retrospective series contained 167 cases (Figure 2). The sample mean is 7.17. Using the same R program, 95% percentile boundaries are 6.57 and 7.86. As we would expect with a larger group size, there is less variation in the mean and the bootstrap confidence interval is more symmetric about the sample mean (Dataset 4¹⁹). The second retrospective series contained 106 cases (Figure 3). It was biased to start with high F values of 25, 20, 16, with a minimum value of 1. The mean was 8.5, with 95% percentile boundaries of 7.5 and 9.5. This shows increase of the mean with some severe cases in the series (Dataset 4¹⁹). The two retrospective series included complete cases and those who did not complete, but were considered successful before they failed to attend. If all 323 cases reported here were combined, the mean was 7.68 inside boundaries of 7.20 and 8.20 (Figure 4). This estimates the long-term average of distress images for populations similar to that attending the clinic.

Destinations

Table 6 shows the destinations of the 130 patients recruited. Nine patients left the project, but continued treatment, after another life event. EMDR was not sufficient for six patients who required further cognitive therapy (from the same therapist). Twelve

attended assessment, consented to the trial, then did not attend treatment (DNA). Patients who dropped out of treatment were divided into those who attended at least two sessions and therefore contributed data, and those who attended once. Questionnaire and other data showed improvement in the drop-outs, not discussed further for reasons of space. Six patients decided to leave EMDR treatment for another therapist. The 50 finishers were compared with the 46 who started treatment but did not finish and for whom all data was collected. No significant differences were detected for any collected parameters.

Discussion

The median number of distress images was seven. We defined and counted the unit “distress image” as that which reduces in distress when treated with eye movements. This definition is validated by the reduction in questionnaire scores. EMDR is considered as a titration of eye movements against distress. Distress memory images can be episodic or semantic. The “distress complex” is the collective noun for those distress images reported by one patient. Three qualifications are required.

Only data from one EMDR therapist is reported. This result requires replication with other therapists, following the same procedure. The two retrospective replications gives some mitigation for this issue. We cannot show replication with other therapists,

Figure 2. First retrospective replication of 167 cases. Final mean = 7.17.

Figure 3. Second retrospective replication of 106 cases, starting with high values. Final mean = 8.50.

Figure 4. All 323 cases (50 + 167 + 106 = 323). Final mean = 7.68.

Table 6. Destinations of patients that underwent EMDR therapy. EMDR, eye movement desensitisation and reprocessing.

Destination	Frequency	Percent
Another traumatic event	9	6.9
Cognitive therapy	6	4.6
Did not attend treatment	12	9.2
Drop-out after 2 sessions	28	21.5
Drop-out after 1 session	18	13.8
EMDR finishers	50	38.5
Medication increase	1	0.8
To another therapist	6	4.6
TOTAL	130	100

because only one was available, but we can replicate within one therapist, across time. Second, the patients were informed of the expected seven image average. This raises the possibility that the seven is an artefact. We considered it necessary, and ethical, to inform them of this to achieve informed consent. It was emphasized that seven was an average and the patient should report all images, to all bad life events or distress triggers. The good before and after scores support the position that all images were reported and treated. Third, this was an uncontrolled case series, designed to observe the natural history of treatment to test a hypothesis. These limitations are dictated by the circumstances of

an acute sexual medicine clinic, where a fast turnover of patients is required and where there is only one psychologist. Legal and practical difficulties limit communication to patients.

Subject to these issues, we can assert that for the typical population attending the clinic, the distress complex tends to contain seven, plus or minus two, distress images. This is demonstrated by the prospective case series that had a median of seven images. The two retrospective series also stabilised in this zone. These results are similar to those in a previous report⁹. The largest retrospective series (of 167) had a mean of 7.17 (with near-symmetric bootstrap 95% interval of 6.67–7.86). In the second retrospective series starting with more severe cases, the mean rises to 8.5. Combining all 323 cases moves the mean back towards seven, which we can consider a stable value in the long term. This observation may be sensitive to variation in patients and method. This demonstrates that the EMDR system is dose dependant, because sufficient EMDR is required to desensitize the whole distress complex. Any trial that compares eye movement or sensory stimulation methods with CBT must ensure that the amount of treatment time is equal across groups and is sufficient to desensitize the distress complex. Commonly, such patients have collected more than one trauma event. This issue is rarely addressed in published trials. If only the worst reported life event is treated, then other distress triggers may be missed. This might limit longer term results. This conclusion may apply to all psychological therapies.

Similar numbers are reported from similar patients. Such similarities are worth noting, but should be considered with due caution since there are differences of definition and method

in each report. First, the Rothbaum *et al.* study treated one distressing memory, but reported discovering an average of six others in both patient groups⁵. This is a total of seven. Second, a trial of EMDR treatment reported that patients were treated until they no longer had PTSD. This required treatment of six trauma memories²⁴. Third, Holmes *et al.*²⁵ counted the number of “hotspots” in a sample of patients in treatment and discovered an average of six, in the context of an average of four intrusive images of different contents.

Observing this attraction towards seven raises the possibility of involvement of the working memory. Seven is identified as the approximate number of information chunks that can be held in the working memory²⁶. If it is assumed that a distress image is a chunk, then perhaps this is a signal from the working memory limit. Working memory capacity is a complex subject, which we cannot simplify here. For reviews see Cowan²⁷, Jonides *et al.*²⁸, and Richardson²⁹. It might be a safer initial claim that EMDR therapy works by unloading a limited capacity memory buffer, without specifying further. PTSD and similar disorder is caused by overloading this buffer.

A possible model to explain the unloading is “reverse learning”, originally postulated by Crick & Mitcheson³⁰. The speed of the EMDR effect implies a physiological explanation⁹. The idea of unloading memory buffers enables several points to be made. Firstly, this is a good explanation for the patient, since such overload is what chronic distress disorder feels like. Second, this enables clinical decisions in the treatment session. For example, on occasion, the patient becomes so distressed, or affected in some other way, that the treatment process stalls. This might mean the memory buffer capacity is saturated. Therefore, the EMDR target image should be progressively decomposed into smaller images, as described above, until distress starts to reduce again. At this point both the EMDR responsive image and the available memory processing bandwidth are defined. An analogy is threading a needle. A thread will not go through the eye of the needle if it is too big, so the size of the thread is reduced until it passes through. This liberated bandwidth enables further synergistic progress. We can now explain the cognitive and emotional change caused by the EMDR procedure. As memory bandwidth is liberated, the patient becomes progressively more able to think rationally. Distress is reduced to zero, or that level permitted by circumstances.

Can anything be said about this memory buffer? First, there must be two limited capacity systems involved. The first contains the whole distress complex and averages seven images. However, when treating each image, we presumably have placed that image into a second buffer, which only holds one. These might be working memory and focus of attention, respectively. It is established that eye movements affect working memory^{31–33}. If EMDR affects working memory capacity, then this is common ground with other therapeutic methods, such as mindfulness training³⁴, and counting during recall³⁵, where similar claims have been made.

The observation of a limit gives an approach to dealing with serious, or complex, cases. Using the distribution in Table 5, 96% of cases report up to 13 distress images. Therefore, only 4% of EMDR cases go to 14, or above. Such cases are either serious,

or the therapist should consider if the limits of EMDR treatment have been reached and for what reason. Reaching image number 14 requires diagnosing between, for example, a child sexual abuse case with panics, in which case continue EMDR, or another issue which may require reconsidering EMDR. When a history of childhood abuse is reported, the fact that seven is average and fourteen is rare, enables patient and therapist to define the task. Patients may ask if they will require other psychotherapeutic help after EMDR. The answer can be given that, if this is required, they will benefit more from other methods once EMDR has unloaded the working memory up to this limit.

Conclusions

Both the observation of the seven images and the speed of treatment are achieved by this minimalist protocol, with decomposition of obstinate flashbacks. This probably accelerates treatment. Only an average of three treatment sessions and five in total were required per patient. It is likely that this version of the EMDR procedure permits the observation of the distress image horizon. With EMDR using the eight stage sequence, difficulties are solved by methods borrowed from cognitive therapy, or evaded by a retreat to the imagined safe place. In our version of eye movement or sensory stimulation therapy, difficulties are usually solved by decomposing the image into smaller elements that can be individually treated. Reducing an unresponsive distress image into smaller units permits us to continue treatment and define the units by their response to treatment. CBT does not permit this, especially if the distress complex is committed to audio or video file for self-exposure. The theory that it is necessary to match the image with some limit of memory processing bandwidth, which shows one sign of working memory, enables an account that facilitates clinical decisions and may improve trials.

Data availability

F1000Research: Dataset 1. : R program files¹⁶, requiring R.app or RStudio.app (on Mac) or equivalent to run (cran.r-project.org), [10.5256/f1000research.15648.d217183](https://doi.org/10.5256/f1000research.15648.d217183)¹⁵

F1000Research: Dataset 2. Demographic data for participants., [10.5256/f1000research.15648.d217186](https://doi.org/10.5256/f1000research.15648.d217186)¹⁷

F1000Research: Dataset 3. The before, after and follow-up scores for the General Health Questionnaire (GHQ-12), the Impact of Events scale (IoE-R) and the Post Traumatic Cognitions Inventory (PTCI), [10.5256/f1000research.15648.d217184](https://doi.org/10.5256/f1000research.15648.d217184)¹⁸

F1000Research: Dataset 4. “F” values for the initial prospective 50 cases and then the two retrospective series of 167 and 106 cases., [10.5256/f1000research.15648.d217185](https://doi.org/10.5256/f1000research.15648.d217185)¹⁹

Grant information

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Acknowledgements

This report has benefited from advice from David Mulhall. A preliminary version of this project was reported at the ninth EMDR European Conference in London, 2008.

References

1. Shapiro F: **Eye movement desensitization: a new treatment for post-traumatic stress disorder.** *J Behav Ther Exp Psychiatry.* 1989; 20(3): 211–217.
[PubMed Abstract](#) | [Publisher Full Text](#)
2. Shapiro F: **Efficacy of the eye movement desensitization procedure in the treatment of traumatic memories.** *J Trauma Stress.* 1989; 2(2): 199–223.
[Publisher Full Text](#)
3. Marks I, Lovell K, Noshirvani H, *et al.*: **Treatment of posttraumatic stress disorder by exposure and/or cognitive restructuring: a controlled study.** *Arch Gen Psychiatry.* 1998; 55(4): 317–325.
[PubMed Abstract](#) | [Publisher Full Text](#)
4. Nijdam MJ, Gersons BP, Reitsma JB, *et al.*: **Brief eclectic psychotherapy v. eye movement desensitization and reprocessing therapy for post-traumatic stress disorder: randomised controlled trial.** *Br J Psychiatry.* 2012; 200(3): 224–231.
[PubMed Abstract](#) | [Publisher Full Text](#)
5. Rothbaum BO, Astin MC, Marsteller F: **Prolonged Exposure versus Eye Movement Desensitization and Reprocessing (EMDR) for PTSD rape victims.** *J Trauma Stress.* 2005; 18(6): 607–616.
[PubMed Abstract](#) | [Publisher Full Text](#)
6. Moreno-Alcázar A, Treen D, Valiente-Gómez A, *et al.*: **Efficacy of Eye Movement Desensitization and Reprocessing in Children and Adolescent with Post-traumatic Stress Disorder: A Meta-Analysis of Randomized Controlled Trials.** *Front Psychol.* 2017; 8: 1750.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
7. Shapiro F: **Eye Movement Desensitization and Reprocessing Therapy.** Third Edition. Wiley, Third Edition. The Guilford Press, 2018.
[Reference Source](#)
8. Hassard A: **Distribution of targets in 400 eye-movement desensitization cases.** *Psychol Rep.* 2003; 92(3 Pt 1): 717–722.
[PubMed Abstract](#) | [Publisher Full Text](#)
9. Foa EB, Cashman L, Jaycox L, *et al.*: **The validation of a self-report measure of posttraumatic stress disorder: the posttraumatic diagnostic scale.** *Psychol Assess.* 1997; 9(4): 445–451.
[Publisher Full Text](#)
10. Weiss DS, Marmar CR: **The impact of event scale-revised.** In Wilson JP, Keane TM, editors. *Assessing psychological trauma and PTSD*, 1997.
[Reference Source](#)
11. Sundin EC, Horowitz MJ: **Horowitz's Impact of Event Scale evaluation of 20 years of use.** *Psychosom Med.* 2003; 65(5): 870–876.
[PubMed Abstract](#) | [Publisher Full Text](#)
12. Goldberg D, Williams P: **A user's guide to the General Health Questionnaire.** Windsor: NFER-Nelson, 1998.
[Reference Source](#)
13. Foa EB, Ehlers A, Clark DM, *et al.*: **The posttraumatic cognitions inventory (PTCI): Development and validation.** *Psychol Assess.* 1999; 11(3): 303–314.
[Publisher Full Text](#)
14. Hornsvelt HK, Houtveen JH, Vroomen M, *et al.*: **Evaluating the effect of eye movements on positive memories such as those used in resource development and installation.** *Journal of EMDR Practice and Research.* 2011; 5(4): 146–155.
[Publisher Full Text](#)
15. Hassard A, Turner H, Smith K: **Dataset 1 in: Dose response and working memory limit in an eye movement desensitization and reprocessing prospective case series.** *F1000Res.* 2018.
<http://www.doi.org/10.5256/f1000research.15648.d217183>
16. Canty A, Ripley B: **boot: Bootstrap r (s-plus) functions.** R package version.
[Reference Source](#)
17. Hassard A, Turner H, Smith K: **Dataset 2 in: Dose response and working memory limit in an eye movement desensitization and reprocessing prospective case series.** *F1000Res.* 2018.
<http://www.doi.org/10.5256/f1000research.15648.d217186>
18. Hassard A, Turner H, Smith K: **Dataset 3 in: Dose response and working memory limit in an eye movement desensitization and reprocessing prospective case series.** *F1000Res.* 2018.
<http://www.doi.org/10.5256/f1000research.15648.d217184>
19. Hassard A, Turner H, Smith K: **Dataset 4 in: Dose response and working memory limit in an eye movement desensitization and reprocessing prospective case series.** *F1000Res.* 2018.
<http://www.doi.org/10.5256/f1000research.15648.d217185>
20. KO McGraw, Wong SP: **A common language effect size statistic.** *Psychol Bull.* 1992; 111(2): 361–365.
[Publisher Full Text](#)
21. Mooney C, Duval RD: **Bootstrapping: A Nonparametric Approach to Statistical Inference.** Sage, 1993.
[Reference Source](#)
22. R Core Team: **R: A language and environment for statistical computing.** 2017.
23. Davison AC, Hinkley DV: **Bootstrap methods and their applications.** 1997.
[Reference Source](#)
24. Marcus SV, Marquis P, Sakai C, *et al.*: **Controlled study of treatment of PTSD using EMDR in an HMO setting.** *Psychother.* 1997; 34(3): 307–315.
[Publisher Full Text](#)
25. Holmes EA, Grey N, Young KA: **Intrusive images and “hotspots” of trauma memories in Posttraumatic Stress Disorder: an exploratory investigation of emotions and cognitive themes.** *J Behav Ther Exp Psychiatry.* 2005; 36(1): 3–17.
[PubMed Abstract](#) | [Publisher Full Text](#)
26. MILLER GA: **The magical number seven plus or minus two: some limits on our capacity for processing information.** *Psychol Rev.* 1956; 63(2): 81–97.
[PubMed Abstract](#) | [Publisher Full Text](#)
27. Cowan N: **The many faces of working memory and short-term storage.** *Psychon Bull Rev.* 2017; 24(4): 1158–1170.
[PubMed Abstract](#) | [Publisher Full Text](#)
28. Jonides J, Lewis RL, Nee DE, *et al.*: **The mind and brain of short-term memory.** *Annu Rev Psychol.* 2008; 59: 193–224.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
29. Richardson JT: **Measures of short-term memory: a historical review.** *Cortex.* 2007; 43(5): 635–650.
[PubMed Abstract](#) | [Publisher Full Text](#)
30. Crick F, Mitchison G: **REM sleep and neural nets.** *The Journal of Mind and Behavior.* 1986; 229–249.
31. Gunter RW, Bodner GE: **How eye movements affect unpleasant memories: support for a working-memory account.** *Behav Res Ther.* 2008; 46(8): 913–931.
[PubMed Abstract](#) | [Publisher Full Text](#)
32. Postle BR, Idzikowski C, Sala SD, *et al.*: **The selective disruption of spatial working memory by eye movements.** *Q J Exp Psychol (Hove).* 2006; 59(1): 100–120.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
33. Maxfield L, Melnyk WT, Hayman GCA: **A working memory explanation for the effects of eye movements in EMDR.** *Journal of EMDR Practice and Research.* 2008; 2(4): 247–261.
[Publisher Full Text](#)
34. Jha AP, Stanley EA, Kiyonaga A, *et al.*: **Examining the protective effects of mindfulness training on working memory capacity and affective experience.** *Emotion.* 2010; 10(1): 54–64.
[PubMed Abstract](#) | [Publisher Full Text](#)
35. van den Hout MA, Engelhard IM, Smeets MAM, *et al.*: **Counting during recall: Taxing of working memory and reduced vividness and emotionality of negative memories.** *Appl Cogn Psychol.* 2010; 24(3): 303–311.
[Publisher Full Text](#)

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Reviewer Report 02 March 2020

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Gaëtan Mertens

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² Department of Medical and Clinical Psychology, Tilburg University, Tilburg, The Netherlands

In this manuscript titled “Dose response and working memory limit in an eye movement desensitization and reprocessing prospective case series” by Hassard and colleagues, the authors investigate the number of distressing images treated in EMDR treatment. The authors predicted that this number should average out to approximately 7 images and indeed based on a sample of 50 patients, this approximate number was achieved and replicated in two sets of archival cases. My overall impression was that this manuscript addressed an interesting question and the results seem to confirm the a priori set prediction. However, I have some serious reservations regarding the validity of the results given potential participants’ and researcher bias and unclarity with regard to how an ‘imagine’ was defined and counted. I also found the rationale for this study not particularly clear and convincing. I expand more on these reservations below.

Introduction:

For me, it was quite unclear to how this specific relates to the discussion regarding the comparison between EMDR and CBT and how this study can show that EMDR therapy is faster than CBT. To my knowledge, CBT is not (necessarily) specifically concerned with treating distressing images of patients. As such, this study is not very informative of how CBT and EMDR can be compared and whether or not EMDR is a more efficient (faster) treatment than CBT. I would suggest to focus the introduction more specifically on EMDR therapy only and how many sessions may be required there.

Also, a clear argument is missing why the authors would expect that patients would, on average, suffer from 7 distressing images. My guess is that this is based on working memory theory in which it has been proposed that the number of distinct units of information that people can keep online in their short term working memory centers around 7 (e.g., Baddeley, 1994)¹. However, to my knowledge, this proposal is somewhat controversial. Furthermore, I’m not sure why the capacity of working memory would have any bearing on patients’ number of distressing images, which are most likely based on long term memory. Why would the capacity of WM limit the number of distressing images of patients that require treatment to 7? Finally, I’m missing a link to

other research investigating emotional memories and images in mental disorders (e.g., Brewin, Gregory, Lipton, & Burgess, 2010; Hackmann, Ehlers, Speckens, & Clark, 2004; Hirsch & Holmes, 2007)^{2,3,4}.

I short, I suggest that the authors remove the second paragraph in which they discuss EMDR therapy in relationship to CBT, but rather focus their introduction on why they expect specifically 7 distressing images and how this may inform us about the number of treatment sessions required (is 1 treatment session sufficient to treat 1 intrusive image?).

Methods:

For me, there seem to be two major problems with the methods relating to this article: First, patients were explicitly informed about the seven images average (see P. 4) and, as far as I can see, also the therapist was aware of the hypothesis that on average 7 images should be expected. This is problematic, as it can easily lead to biases and desirable responding (Orne, 1962)⁵. This, to me, seems a major threat to the validity of the results, as it may just reflect bias on the part of the experimenter and demand compliance on the part of the patients. Is there any argument/reason that the authors have that their results do not reflect bias and experimental demand? In my view, this study should be replicated with blinded experimenters and patients.

A second major threat to the validity of the results is that it is not clearly defined what a 'distressing image' is and how this was counted. Also, apparently, larger images could be split up into smaller event sequences and these would then be considered as separate sensory images (see P. 4). This lack of a clear definition of what an image is and the possibility to subdivide images provides even a greater amount of freedom for the authors to define distress images and for the numbers to influence by biases. The authors should (have) define(d) more explicitly what they considered to be a distressing image. Furthermore, it should be clarified how this was counted/calculated and by who. If it was done by only one author, this should be clearly indicated as a potential threat to the reliability of the count. If counting was done by several authors (which would be much better), inter-rater reliabilities should be calculated and reported.

Discussion/interpretation:

The authors conclude in the Discussion that "the distress complex tends to contain seven, plus or minus two, distress images". However, reading the results, the average number of images was 7.68 within the boundaries 7.20 and 8.20 (based on all cases). This seems more than the expected number (i.e., closer to 8). Furthermore, there is substantial variation between the patients in the number of distress images (1-23). I wonder whether these results support their hypothesis. It seems in fact that the actual number is slightly higher than 7. Furthermore, the authors mention in the Discussion that "this attraction towards seven raises the possibility of involvement of the working memory". However, as I mentioned previously, to me distress images are related to long term memory, rather than working memory. It seems unlikely that any of the patients has a working memory span of 23. Furthermore, 7 images and more tends towards the highest percentiles of WM capacity (in healthy participants/students). In contrast, there is some evidence to suggest that typically anxiety patients have reduced WM capacity (Hayes, Hirsch, & Mathews, 2008)⁶. Hence, it seems unlikely that the amount of distress images indeed reflects or is related to WM capacity. A more direct test of this hypothesis would be to measure patients' working memory capacity and correlate the number of reported distress images directly to WM span scores.

Taken together, my worry regarding this work is that it may be critically influenced by biases on the part of the experimenters and patients. As far as I can judge, no precautions have been taken to protect the results against such biases and there are no clear arguments given why the results

can be considered to be robust against these biases. Additionally, I have reservations about the embedding of the motivation for and results of this study in the wider literature. Nonetheless, the topic of study (number of distressing images and number of required treatment sessions) is definitely of interest for the literature on psychotherapy. I suggest additional clarifications and research (i.e., double blind, clear definitions, independent raters) to permit more clear conclusions.

Minor comments:

- Table 5: The cumulative percentage do not seem correct. Particularly, 2 patients reported 3 or less distressing images (4%). However, in the cumulative % column, it says 2%.

References

1. Baddeley A: The magical number seven: still magic after all these years?. *Psychol Rev.* 1994; **101** (2): 353-6 [PubMed Abstract](#) | [Publisher Full Text](#)
2. Brewin CR, Gregory JD, Lipton M, Burgess N: Intrusive images in psychological disorders: characteristics, neural mechanisms, and treatment implications. *Psychol Rev.* 2010; **117** (1): 210-32 [PubMed Abstract](#) | [Publisher Full Text](#)
3. Hackmann A, Ehlers A, Speckens A, Clark DM: Characteristics and content of intrusive memories in PTSD and their changes with treatment. *J Trauma Stress.* 2004; **17** (3): 231-40 [PubMed Abstract](#) | [Publisher Full Text](#)
4. Hirsch C, Holmes E: Mental imagery in anxiety disorders. *Psychiatry.* 2007; **6** (4): 161-165 [Publisher Full Text](#)
5. Orne M: On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. *American Psychologist.* 1962; **17** (11): 776-783 [Publisher Full Text](#)
6. Hayes S, Hirsch C, Mathews A: Restriction of working memory capacity during worry. *J Abnorm Psychol.* 2008; **117** (3): 712-7 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

No

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Fear conditioning, learning, memory

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 10 Jun 2020

Alan Hassard, Derriford Hospital, Plymouth, UK

Response to Dr Mertens

Thank-you for reviewing our report. The critique made has validity. My defense, or at least plea for mitigation, is partly theoretical and partly about the limitations of research in a clinical situation.

1) How should we start research? I suggest that the usual method in psychology is to start with a theory and test it. This would be a rationale or theory (a priori.) or derived from previous research.

This did not happen here. There was no previous theory, concerning the influence of working memory or images. There was an observation made in clinical practice that required whatever test that could be contrived in the limitations of that situation. If we can test and replicate the observation, perhaps we can find an explanation (a posteriori). This is a legitimate inquiry. One might observe that the Earth rotates around the Sun at an average distance of 150 million km and then develop an explanation.

2) The prediction was not that each patient will report 7 distress images. It was that the distribution of images for 50 patients will show a mean, mode or median of seven.

3) The observation was made in clinical practice by myself. It required testing and there was no other way of testing other than collecting data as one went along. This required the originator of the hypothesis to also be the collector of the data. If this arouses concern about experimenter bias or curing the patients, then there is no defense against this charge, other than necessity.

4) There are 3 ways to reduce this problem. First, The briefing clearly explained to patients that seven was the average but they should report all distress images they needed. We think it reasonable that the patient would understand that they were not expected to produce exactly seven. It was made clear that all distress images should be reported, to any bad life events, panic, flash-forwards or any other unlabelled interoceptive bad core effect.

We also argue that informed consent required this. One premise of this work is that patients who have suffered more than 7 bad life events, such as years of domestic abuse, still find their place in this distribution. Repeated episodes become semantic memories, which are also EMDR targets. To achieve informed consent, this information needs to be explained.

5) The before and after test scores given in Table 2.3 and 4 show high difference, low probability, changes. It is a reasonable inference that this could only happen if the whole "distress complex" of average 7 images was treated. If the patients were restricting to a report of 7, to please the therapist, this would not happen. Half the patients, with above seven images, would not complete treatment and (probably) retain high scores.

6) The inclusion of the two archival, audit, series was intended to support the prospective series. We could not replicate the result across therapists but could across time with one therapist. This is the weakest argument, so I am writing it last. One could argue that the same problems occurred in all 323 cases.

7) A major problem raised is that the therapist knew the prediction and might bias the results to seven. This is valid, but what to do about it? The solution offered is a double-blind replication in which both patient and therapist are not informed about the seven. This is perhaps the ideal but how is this achieved?

Arguments about keeping the patient in the dark are given above. How does one find an experienced EMDR therapist to do this without any discussion of the reason? The EMDR method advocated here is different from the conventional EMDR method. That is part of the demonstration reported here. Even if the resources were available and the situation permitted, it would require the EMDR therapist(s) to spend one or two years with 50 patients without enquiring or finding out why this particular EMDR version was in play. This is not the same as the blindfolded assessment used in some trials. Perhaps it is possible in well-funded research institute trials but how would one achieve that status? Perhaps by demonstrating it in an observational prospective case series. However, that demonstration would inform potential EMDR therapists of the seven.

8) Another way could have been compared with other EMDR therapists. Other therapists were initially in the project but left due to misadventure or retirement.

9) The introduction addresses the odd problem Of unbalanced randomized controlled trials (RCT) for EMDR versus CBT. The question raised is how does that lead to this perspective series. If trials are to balance treatment time between the 2 methods, then how much treatment time is needed? This will be controlled by how much treatment is needed. If there is a limit, even if only expressed statistically, on the number of images, then that can define how much treatment is needed. Our report address this issue, since we could not do an RCT.

An RCT that addresses this issue has recently appeared. It demonstrated EMDR patients needed 21 hours, average, to discover and treat 4.2, trauma memories compared with 63 hours for 1.5 memories for prolonged exposure. (Stanbury et al 2020)

Stanbury, M., Drummond, P.D., Laugharne, J., Kullack, C., & Lee, C.W. (2020). Comparative Efficiency of EMDR and Prolonged Exposure in Treating Posttraumatic Stress Disorder: a Randomized Trial. *JHournal of EMDR Practice & Research*, 14(1), 2-12.

10) This project was intended to make the best test of a clinical observation, that could be made when we we obliged to stay in the clinical situation. There was no research grant and only minimal support from other sources. The project is essentially little more than an

audit, which also tests an observation. The method and R-program used were transferred to routine audits.

Alan Hassard
Plymouth, UK
10 June 2020

Competing Interests: No competing interests

Reviewer Report 19 March 2019

<https://doi.org/10.5256/f1000research.17073.r44265>

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Lonneke I.M. Lenferink

Department of Clinical Psychology and Experimental Psychopathology, Faculty of Behavioral and Social Sciences, University of Groningen, Groningen, The Netherlands

In this study the authors conducted a prospective case series study to test the hypothesis that on average 7 distressing images need to be treated in EMDR treatment in a sample of patients who experienced various traumatic events. My suggestions for improvements of the manuscript are listed below.

Abstract:

1. "This result was replicated twice in separate retrospective case series." It is not clear from the Background or Methods section in the abstract that a replication study was conducted. Please provide more information about this in the Abstract.
2. "This required three treatment sessions in a total of five appointments, on average." This is somewhat confusing. How can three sessions be offered in five appointments?
3. "If this bandwidth is liberated by treatment, this permits the cognitive and emotional change observed in EMDR treatment." It is not clear from the abstract that cognitive and emotional responses were assessed in this study. Please provide information in the abstract about the instruments and analyses used in this study.

Introduction:

1. "There is no explanation of how this procedure works." In my view, this is too strongly phrased. Prior research (e.g., from van den Hout & Engelhard) have offered possible explanations for how EMDR works.
2. On the basis of clinical experience, we hypothesize that EMDR is superior to cognitive behavioural therapy (CBT) because it is faster." This is not really convincing. There is a large body of research comparing CBT with EMDR. Please cite these studies.
3. "The published trials do not always balance the number of sessions or treatment time."

Please provide a citation here.

4. "Therefore, EMDR clients are getting 10 hours of treatment, while CBT clients are getting 70 hours. If the result shows equal results for each therapy, then we should conclude that EMDR is seven times faster than CBT and avoids the problem of homework compliance." This conclusion is somewhat overstated. It is true that, if shown to be equally effective, EMDR avoids the problem of homework compliance. However, working on homework assignments in CBT or processing the aftermath of EMDR in between sessions, can both be taxing for clients and takes up time. So the conclusion that EMDR is 7 times faster leaves out the part that EMDR could be emotionally taxing for clients and takes time to process.

Methods:

1. The original analysis plan, using non-parametric, required 50 patients to complete. However, this plan was superseded by the analysis described below." Please provide more details about this. What type of non-parametric tests were planned? Was the original number of 50 patients based on a power-analysis? If so, please provide details.
2. "Patients in the Genitourinary Medicine clinic (GUM) were offered EMDR whenever distressing images were reported." What kind of patients were offered EMDR in the GUM? Please provide more details about the clinic and patients.
3. "No a prior judgements of single trauma event, multiple events or complexity of case were made." What do you mean with "no a prior judgement"?
4. "EMDR treatment reduces clarity and perception of distress images and consequently the distress score reduces." This sentence does not fit the heading "Measures" and better fits in the "Therapeutic procedure" section.
5. "On the first treatment appointment, the Foa questionnaire was also given." Why did you only assess the Foa questionnaire at the start of treatment and not also at the end?
6. "We investigated if there were any systematic differences between completers and dropouts, using the data collected." This sentence is more appropriate under the heading "Data analysis". Please provide details about the statistical approaches used to assess differences between completers and dropouts.
7. The letter contained a list of recorded distress images and the three questionnaires." Please provide more details. Why did the letter contained a list of distress images? And which three questionnaires?
8. Please summarize which statistical methods were used in the Data Analysis section, instead of referring to the R script only.
9. The "Two Informal Replications" part is not clearly introduced earlier in text. It is now somewhat abruptly phrased in text. To avoid confusion, it would be helpful to refer to Sample 1, Sample 2, and Sample 3 throughout the text. For instance, the Results section starts with describing the patients, but it is now not clear of which sample the characteristics are described.
10. Please provide more details about the measures used (e.g., how many items, answer options).

Results:

1. Please provide details on the outcomes of the tests to compare completers with dropouts.

Discussion:

1. "This probably accelerates treatment. Only an average of three treatment sessions and five in total were required per patient." The high dropout rate (i.e., only 50 out of 130 completed treatment) is an important limitation of this study and needs to be taken into account when drawing conclusions.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Clinical psychology, trauma, grief

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 10 Jun 2020

Alan Hassard, Derriford Hospital, Plymouth, UK

Response to Dr Lenferink.

This is a response to the qualified approval of Dr Lenferink and answer to issues raised.

(1) It is advised that more information is included in the abstract. However, the abstract is intended as a summary so not all issues can be covered there. Issues raised about the abstract are considered below. For example, emotional and cognitive change was measured with the questionnaires give in the method.

(2) There was no prospective replication. The two replication series were an attempt to mitigate the major problem with this project. That is both the prediction and data collection were by the same person. For more on this issue, please see reopens to Dr Mertens.

(3) There was a total of five appointments, average. First, assessment and briefing. Second, three EMDR treatment appointments. Last, the follow-up and review appointment. I used "session" and "appointment" to mean the same thing, which might have caused confusion.

(4) One aim of this study was to investigate an idea about how EMDR works. This is considered in the discussion. There are many papers speculating how EMDR works. We could not consider them all here.

(5) There is no citation here concerning the issue of unbalanced trauma memory exposure time in control and EMDR groups, because that is an issue being raised in this paper. A discussion of it can be found in Chapter 12 of Shapiro(2018). I had not read this when the report was written.

Shapiro F. (2018). Eye Movement Desensitization and Reprocessing (EMDR) Therapy. Guilford Publications.

(6) The argument is to compare exposure time to trauma memories in the therapeutic procedure. No doubt both groups are "processing", that is thinking about the trauma experience, from beginning to end of the treatment.

(7) The original advice from the university statistics service was 50, based on a power analysis program. I cannot now provide further details which I understand is not the best answer. However, it became apparent as the data came in that this advice was wrong of at least based on a misunderstanding. The number of images was not based on a random distribution. Nothing was known about their distribution. That is what we were investigating.

(8) Further information is requested about the patients, but not clear what is needed. This is a medical clinic providing sexual health and related services. This includes sexual assault. Other patients who attended for medical reasons were included if they reported trauma memories. Details in Table 1.

(9) No prior judgment means that no judgments about single or multiple bad life events or other anxiety issues were made before treatment. All entered EMDR.

(10) This sentence describing changes in image clarity and distress is included in the methods section to describe what needs to be measured.

(11) The Fos PTSD questionnaire was intended as a measure of case severity to correlate with case characteristics such as age, sex, etc. The three questionnaires used to measure change were not PTSD specific.

(12.) Before and after the scores were analyzed with the Wilcoxon signed-rank test. The effect was also expressed with the Common language effect size This is reported under Tables 2, 3, and 4.

How should we test the result of seven? We could argue that it is an observation. Since there is no theoretical model there is no conventional statistical model to test it against. We demonstrate it with the running mean plots in Figs 1,2,3 and 4. We also investigated the distribution using bootstrapping randomization statistics as described.

(13) No difference was found in a comparison between completers and dropouts.

Tests:

Age/Mann Whitney test

Sex/Chi square

Married/single/Chi square

Employed?/Chi square

Presented trauma Chi square

Mental health/addiction/ Chi square

Presence of Panic/Chi square

Trauma event, how long ago/Mann Whitney test

(14.) The high drop out from the treatment rate is typical of this clinic. Nobody wants to attend a sexual health clinic. However, we also had added an intention to treat the value of 6 images made up of the 50 completed cases, plus the 49 who attended at least two sessions and recorded at least one F value.

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Competing Interests: No competing interests

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