



Efficacy of EMDR in children: A meta-analysis

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ABSTRACT

The efficacy of eye movement desensitization and reprocessing (EMDR) in children with post-traumatic stress symptoms was meta-analytically examined from the perspective of incremental efficacy. Overall post-treatment effect size for EMDR was medium and significant ($d = .56$). Results indicate efficacy of EMDR when effect sizes are based on comparisons between the EMDR and the non-established trauma treatment or the no-treatment control groups, and the incremental efficacy when effect sizes are based on comparisons between the EMDR and the established (CBT) trauma treatment. The discussion focuses on the future replication of EMDR findings and further research on post-traumatic stress in children.

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Post-traumatic stress disorder (PTSD) is an anxiety disorder that is rooted in the experience of events involving actual or threatened death or serious injury, or a threat to the person itself or others when intense fear, helplessness or horror is induced at the time of the event DSM-IV-TR (American Psychiatric Association, 2000). Children can experience trauma due to human action, such as domestic violence, abuse, assault or war (interpersonal violence). Noninterpersonal trauma includes life

threatening illness, accidents, and natural disasters. In addition, children can be the victim of single traumatic experiences (Type I trauma) or suffer from enduring adversities (Type II trauma) (De Bellis & Van Dillen, 2005). After exposure to a traumatic event, children may display a range of disorders, including acute stress disorder (ASD), post-traumatic stress disorder, depression, generalized anxiety disorder, childhood traumatic grief, specific phobias, and separation anxiety (Stallard, 2006). Concerns are still raised about the validity of the diagnosis of PTSD when it applies to children (American Academy of Child and Adolescent Psychiatry, 1998), about whether or not the diagnosis must be associated with the decreased functioning in children, and about the most salient characteristics of PTSD

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in children when compared to adults (Adler Nevo & Manassis, 2005). There are also differences between the children that depend on their developmental stage, for example, regarding the presentation of symptoms (Beer & De Roos 2008).

Salmon and Bryant (2002) reported that an incidence of PTSD differs across and within the nature and severity of events experienced, and depends on proximity to the trauma, the child's individual perception and consequently, impact on the child, time passed since the trauma took place, and trauma measurements. PTSD is thus a heterogeneous condition, wherein different factors may contribute to PTSD development. This in turn may contribute to the inconclusive evidence of the exact prevalence and incidence rates of PTSD in children, which have been shown to vary between the zero percent and the extremely high percentages, depending on the nature of the trauma to which the children were exposed (De Bellis & Van Dillen, 2005; Kilpatrick, Ruggiero, Acierno, Saunders, Resnick & Best, 2003; Yule, 2001). For instance, children who experience enduring adversities, direct exposure to traumatic events, and interpersonal violence, such as being kidnapped, witnessing the death of a parent, or suffering from domestic violence, have increased risk of developing PTSD (De Bellis & Van Dillen, 2005; Kilpatrick et al., 2003; Pine, 2003).

Among the trauma therapies, cognitive behavioral therapy is qualified as an established treatment (e.g., Saxe, MacDonald & Ellis, 2007). A recent systematic review of effects of interventions for trauma symptoms in children and adolescents revealed that individual and group CBT was most effective (Wethington, Hanhn, Fuqua-Whitley, Sipe, Crosby & Johnson, 2008). CBT for trauma in children is based on the principles of cognitive and learning theories and aims to decrease negative child emotions and behaviors, and to transform dysfunctional cognitions and attributions about the traumatic event (Saunders, Berliner & Hanson, 2004). Trauma-focused CBT (which has proved to be efficacious for children with a sexual trauma, but also for children with other traumas (Berliner, 2005; Cohen & Mannarino, 2008) consists of multiple components, including: trauma narrative, in vivo mastery of trauma reminders, affect modulation, cognitive processing, psycho-education, relaxation, parenting skills, conjoint child–parent session, and enhancing safety, healthy sexuality, and future development (PRACTICE) (Cohen, Mannarino, Perel & Staron, 2007). The number of sessions varies between 12 and 16. Methods of exposure are part of CBT for trauma. These methods focus on tolerable exposure to trauma arousal to establish mastery of the traumatic memory and accompanying emotions, developing a sound and reliable narrative of the trauma to diminish conditioned anxiety (De Bellis & Van Dillen, 2005). Saxe et al. (2007) reported that treatment with exposure-based techniques, such as flooding therapy (Saigh, Yule & Inamdar, 1996) and gradual exposure (e.g., Cohen & Mannarino, 1993), seem to show substantial potential for treating children with PTSD symptoms.

As even well-established and empirically supported trauma therapies may not be efficacious in each single case, and knowledge about the causes and treatment of trauma increases constantly, new therapies are developed that may be more efficacious. A new and promising therapy for trauma, eye movement desensitization and reprocessing (EMDR), was first described in 1989 and developed in the 1990s by Francine Shapiro. She initially used EMDR for treating adults with traumatic stress disorder. With EMDR, the traumatic memory is desensitized by short imaginal exposure to this memory and the subsequent offering of bilateral stimuli. This is repeated until the accompanying level of disturbance has disappeared and the dysfunctional cognitions about the trauma have become functional (Shapiro, 2007).

Worldwide, professionals have now embraced EMDR (e.g., psychologists and psychiatrists) for treating clients who are diagnosed with PTSD. EMDR is an 8-phase treatment approach and is applicable to both adults and children. EMDR practice is guided by the adaptive information processing model (AIP model) (Shapiro, 2007). Shapiro stressed that the AIP model should be regarded as a working hypothesis only. In general, with the AIP model it is supposed that the EMDR phases

induce a physiological condition in which adequate information processing is achieved: unprocessed memories of traumatic experiences become linked up with networks already including healthy processed memories. The AIP model shares features with the emotional processing model, which explains the reduction of fear in anxiety disorders (Foa & Kozak, 1986, 1998) in that the protocol and its procedures facilitate the access to emotional networks and the integration of new information. Different in the AIP model, however, is that information within and between memories is an unprompted and spontaneous linking in, whereas in the emotional processing model it is considered that new corrective information, incompatible with the pathology, follows from recurrent prolonged exposure. Thus, free association and distancing is allowed by means of the EMDR procedure; within the emotional processing model free association is generally not allowed (Lee, 2008; Rogers & Silver, 2002; Solomon & Shapiro, 2008).

EMDR is applied by means of a standardized protocol. The EMDR protocol consists of a structured sequence of treatment components that have been identified as being effective across various trauma treatment modalities. With EMDR a three-pronged approach is used, which includes questions regarding the etiology of the traumatic event (past), the triggers of PTSD symptoms (present), and the installation of future templates related to adequately coping with upsetting events (future) (Shapiro, 2001). For children an adapted protocol is used, with age appropriate modifications suggested by Tinker and Wilson (1999), Greenwald (1999) and Adler-Tapia and Settle (2008).

In short, EMDR treatment starts with taking history and planning treatment, explanation of and preparation for EMDR (*history taking and preparation*). The therapist subsequently asks the client to focus on the traumatic memory by means of directive questioning. The client is asked to give a negative, dysfunctional cognition related to the traumatic memory, and in addition, to create a positive, functional cognition. Then, attention is given to the emotion that is connected to the memory and dysfunctional cognition, and the client is asked to find places in the body where the physical phenomena are felt (*assessment*). After that, the client focuses on the traumatic memory and its associated dysfunctional cognition, emotion and the physical sensations in combination with the bilateral stimulation (one series of stimuli). Each new connected association with the traumatic memory is followed by a new series of stimuli. The level of disturbance is repeatedly measured on a ten point Likert-scale (Subjective Units of Disturbance (SUD)) until substantially decreased to zero (*desensitization*). Then the traumatic memory is connected with the earlier formulated functional cognition on the Validity of Cognition Scale (VOC), a seven point Likert-scale, while conducting new sets of stimuli. This is repeated until the client assigns a 7 to the functional cognition (*installation*). Finally, the therapist checks whether physical sensations are still present (*body-scan*), followed by positive *closure* and *re-evaluation*. The number of sessions required varies according to the type of traumatic event (Type I versus Type II) and the severity of the psychopathology.

Initially, saccadic eye movements were regarded as a key element in the EMDR therapy. However, other external bilateral stimuli have also been used in the EMDR treatment, such as taps (tapping the hands of the therapist) (Beer & De Roos 2004) and ear tones (Shapiro, 1993, 2007). As such, bilateral stimuli are considered to play a parallel role with other treatment components. With EMDR unprocessed memories of traumatic experiences, stored in neural networks, become linked with the adaptively processed memories of positive experiences, which are referred to as reprocessing (Shapiro, 2007).

The clinical efficacy of EMDR in post-traumatic stress disorder treatment for adults has been well established (Bisson, Ehlers, Matthews, Pilling, Richards & Turner, 2007). That is, the efficacy of the EMDR's application to trauma treatment has been demonstrated in approximately 20 controlled studies, in which EMDR was compared to psychopharmaca and various forms of psychotherapy, on the basis of which the practice guideline of the American Psychiatric Association (2004) and the Department of Veterans Affairs and Department

of Defense (2004) classified EMDR as an effective treatment for PTSD. The same status is also reflected in numerous international guidelines (Bleich, Kotler, Kutz & Shalev, 2002; Dutch National Steering Committee Guidelines Mental Health, 2003; National Institute for Clinical Excellence, 2005; Sjöblom, Andreewitch, Bejerot, Mortberg, Brinck & Ruck, 2003).

The EMDR, although widely used, has been subject to a blistering discourse about its (incremental) efficacy. The EMDR efficacy has been debated for several reasons, but mainly with reference to the absence of an empirically validated model proficiently explaining the effects of the EMDR method (Gunter & Bodner, 2008; Perkins & Rouanzoin, 2002) and the role of the considered working mechanism in the form of the bilateral stimuli (Lohr, Lilienfeld, Tolin, & Herbert, 1999). It has been demonstrated nevertheless that eye movements contribute to less vivid and unpleasant memories in people with non-clinical symptoms (Andrade, Kavanagh, & Baddeley, 1997; Barrowcliff, Gray, MacCulloch, Freeman & MacCulloch et al., 2004; Kavanagh, Freese, Andrade, & May, 2001). Besides, it has been found that eye movements decrease psychophysiological arousal and increase parasympathetic activity in people with PTSD symptoms (Elofsson, von Schëele, Theorell, & Sondergaard, 2008; Sack, Lempa, Steinmetz, Lamprecht, & Hofmann, 2008). Several hypotheses have been suggested – and are the focus of current research – to explain the mechanism of bilateral stimulation and the mechanism of the processing itself as posited with the AIP model (Shapiro, 1995, 2001, 2007; Solomon & Shapiro, 2008). These hypotheses pertain to the EMDR inducing a REM sleep state-like condition (e.g., Stickgold, 2007), the working memory account (e.g., Gunter & Bodner, 2008), the investigatory reflex account (e.g., Barrowcliff et al., 2004; MacCulloch & Feldman, 1996), the increased hemispheric communication (THC) account (e.g., Christman, Propper, & Dion, 2004), or the hypothesis of relaxation (Shapiro, 2007). It is beyond the scope of the current study though to discuss all these accounts in detail.

The efficacy of EMDR for adults with PTSD symptoms has been demonstrated in several meta-analyses (Bradley, Greene, Russ, Dutra, & Westen, 2005; Davidson & Parker, 2001; Seidler & Wagner, 2006), but incremental efficacy, which means that a new treatment should add incremental value to established treatments, has not yet been supported. It should be noted that studies comparing the EMDR treatment with the non-established trauma treatments (Treatment As Usual), studies with a no-treatment control group and non-controlled studies do not allow testing incremental efficacy. These studies may certainly detect significant treatment effects, but cannot corroborate the incremental efficacy of EMDR. For example, in a meta-analysis of eye movement desensitization and reprocessing, Davidson and Parker (2001) found significant effect sizes for comparisons involving nonspecific therapy clients, studies using a control group that did not receive treatment and for non-controlled studies. Although within group analyses showed significant pre- to post-treatment changes for the EMDR groups, these significant results disappeared when comparisons were made with clients who were treated with (established) exposure techniques. This was also true for analyses only including clients with DSM-III diagnosed PTSD symptoms. Similar results were reported in Seidler and Wagner's (2006). From these meta-analytic reviews it may thus seem that EMDR could be regarded as an effective trauma therapy among other established trauma therapies.

The goal of this study is to provide a meta-analytic overview of the studies that examined the effects of EMDR in children with post-traumatic stress symptoms, while taking into account the criterion of incremental efficacy. The incremental efficacy of a treatment can only be demonstrated if generic treatment factors, such as the therapist's attention, the client's positive expectations about treatment outcome (Lohr et al., 1999) and the standardization of the treatment (Schulte, Kunzel, Pepping, & Schulte-Bahrenberg, 1992) can be controlled. The influence of the generic treatment factors can only be ruled out when a new treatment is compared with an established treatment, as generic treatment factors can be considered common to the new and established treatment. It is thus not

possible to test incremental efficacy when using a treatment as usual or waiting list control group design. Lohr et al. (1999) stated that "If the novel treatment shows a stronger, more general, and longer lasting effect than an empirically supported treatment, or if it more efficiently attains the same results, it will also accrue incremental efficacy", (p.195).

To our knowledge, no meta-analysis has been conducted examining the incremental efficacy of EMDR in children. Meta-analysis is a method for combining the numerical results of studies, having used different research methods and having produced different outcomes. With meta-analysis, researchers are enabled to discover the consistencies within a set of apparently inconsistent findings. As such, more accurate conclusions can be drawn than those presented in any of the separate studies (Durlak & Lipsey, 1991). Due to increased statistical power, small effects can be taken into account, and because systematic bias in the interpretations of results is reduced, a reliable quantitative estimation of the efficacy of EMDR in children can be accomplished.

The first aim of this meta-analysis is to determine the magnitude of the difference (i.e. effect size) in PTSD symptoms between the children receiving EMDR and the children receiving control treatments. The second aim is to investigate which particular treatment factors, designated as moderator variables, do have an impact on the magnitude of effect sizes. To examine whether incremental efficacy can be demonstrated for EMDR, effect sizes for three different types of control groups are computed: control groups receiving non-established treatments for post-traumatic stress symptoms, waiting list control groups, and control groups receiving established treatments for post traumatic stress symptoms. The influence of nonspecific treatment factors is demonstrated if the effect size for comparisons between the EMDR and the non-established treatments or a waiting list control condition is significant. A significant and positive effect size for comparisons involving established PTSD treatment, such as CBT, indicates that EMDR shows efficacy in treating children with PTSD symptoms. Finally, according to Lohr et al. (1999), incremental efficacy also includes the aspect of efficiency: "if the treatment more efficiently attains the same results". Therefore, moderators in the meta-analysis are used to analyze the efficiency of the EMDR treatment, by analyzing both the number of EMDR sessions and the flexibility in the number of sessions that were offered.

1. Method

1.1. Selection of studies

A literature search was conducted into the effects of EMDR on PTSD symptoms in children. First, we searched for studies in computerized databases, including PsycINFO, MEDLINE, ERIC, Google Scholar, and the Social Sciences Citation Index (SSCI). The databases were explored with a range of keywords given in different combinations: EMDR, eye movements, reprocessing, trauma, PTSD, traumatic stress disorder, child*, girls, boys, therapy (An asterisk indicates that the search was not limited to the particular word or fragment).

Second, we used the ancestry method to find more studies of childhood trauma in reviews and articles reporting on empirical studies, that is; reference sections of articles were inspected for relevant studies that had not yet been detected. When there was doubt about the relevance of these articles, they were visually inspected.

Authors were contacted if their data did not provide enough statistical information for the calculation of effect sizes. Some authors, investigators and clinicians were also contacted for design questions (e.g., to verify the random assignment of subject to different experimental conditions) and to establish whether or not they knew of any unpublished papers.

1.1.1. Inclusion criteria

Criteria for inclusion into the meta-analysis were as follows:

(1) Studies had to include control groups (children receiving established trauma treatments, children receiving usual care, or children

in a waiting list control procedure); (2) children had to be treated for post-traumatic stress reactions; (3) studies had to randomize children across the experimental and control groups; (4) studies had to include children up to 18 years of age; and (5) studies had to provide post-treatment trauma scores, thus offering information enabling us to calculate effect sizes for the difference between the experimental EMDR group and the control children at post-treatment.

The literature search resulted in 7 studies (see Table 1) that met the inclusion criteria. Initially, 22 studies that investigated trauma in children with EMDR were identified. However, 11 studies were excluded because of the absence of the control group children, two studies were excluded because children with spider phobia were treated with EMDR, and two studies were excluded because it was not possible to derive statistical data relevant for the calculation of effect sizes (e.g., one author could not be reached).

1.2. Measurements of trauma

Most studies used a range of measurements to measure post-traumatic stress reactions and child behavior problems, including depression and anxiety. The scales that were most frequently used to measure PTSD symptoms were the Child Report of Post-traumatic symptoms (CRI; Pynoos, Frederick, Nader, Arroyo, 1987); Child Report of Post-Traumatic Symptoms (CROPS; R. Greenwald & Rubin, 1999); Impact of Events Scale (IES; Horowitz, Wilner, & Alvarez, 1979), and the Parent Report of Post-Traumatic Symptoms (PROPS; Greenwald & Rubin, 1999). One of the studies (Rubin et al., 2001) used the Child Behavior Checklist (CBCL) to measure child-internalizing problems (depression and anxiety, withdrawal, and somatic complaints (Achenbach, 1991; Achenbach & Edelbrock, 1996), a measure not specifically developed to measure traumatic stress reactions. For the purpose of this meta-analysis, trauma scales were selected that were mostly used to assess post-traumatic stress reactions. Excluded for trauma measurement were scores on the Subjective Unit of Disturbance (SUD) and on the Validity of Cognition scale (VOC), because those measurements are highly vulnerable to demand characteristics (Acierno, Hersen, Van Hasselt, Tremont & Meuser, 1994).

1.3. Coding the studies

Each study included in the meta-analysis was coded for client, design, intervention and publication characteristics. Client characteristics were gender (percentage of girls) and age of the child (mean age). Design characteristics were the percentage of study completers, follow-up measurement or not, the type of control group: non-established (usual care or waiting list) or established trauma treatment (CBT), and type of informant (child, or parent and child). Intervention characteristics were the number of sessions (three or fewer, or more than three) and flexibility of the sessions (flexible vs. not flexible). Finally, the publication year for each study was coded. Categorical moderator variables were types of study control group, follow-up measurement, flexibility of sessions, and type of informant. Year of publication, percentage of study completers, gender (percentage of boys and girls), child age, the effect size for differences in trauma between the experimental and control group at the pretest, and the number of sessions were continuous moderators.

1.4. Calculation and analysis of effect sizes

To examine the difference in trauma scores between the experimental group (EMDR) and the control group (waiting list control, usual treatment, and established treatment) Cohen's *d* was calculated, using data from the most recent post-treatment trauma symptoms (e.g., when there were two post-treatment measurements, data from the second post-treatment measurement were used). Cohen's *d* was usually calculated on the basis of mean scores and standard

Table 1
Study characteristics of the studies included in the meta-analysis.

Study	Year	Traumatic event/behaviors	Reported DSM-IV diagnosis	N EMDR	N study controls	N sessions	Age EMDR	Type of study controls	Measurements used for meta-analysis	<i>d</i> post treatment	<i>d</i> pre treatment
Chemtob, Nakashima, Hamada & Carlson	2002	Trauma; hurricane; anxiety & depression	DSM-IV	17	15	3	6–12	Waiting list	CRI	.55	.18
Jabberghaderi, Greenwald, Rubin, Zand & Dolatabadi	2004	Trauma; sexual abuse; anxiety and depression	-	7	7	4–8	12 and 13	CBT	PROPS, CROPS	.36	-.63
Jeffres	2003	Trauma; different events, internalizing and externalising	-	19	16	3	8–12	Waiting list	UCLA	1.45	-.23
Roos, Greenwald, den Hollander-Gijsman, Noorthoorn, de Jongh	2008	Trauma; firework disaster enschede internalizing and externalising	-	18	20	3.17	4–18	CBT	PROPS, CROPS	.22	.05
Rubin et al.	2001	Trauma; different events; internalizing & externalising	-	23	16	≥5	6–15	Treatment as usual	CBCL	.61	.54
Soberman, Greenwald & Rule	2002	Trauma; different events; externalising	-	14	15	3	10–16	Treatment as usual	PROPS, CROPS	.71	-.08
Ahmad, Larsson, & Sundelin-Wahlsten	2007	Type I and II trauma	DSM-IV	17	16	≥4	6–15	Waiting list	PTSS-C	.07	.00

Table 2
Continuous moderator analyses explaining post-treatment effect sizes.

Moderator variables	N	k	b	z
Year of publication	209	7	-.51	-2.97**
Percentage of study completers	209	7	-.63	-3.68***
Child gender	209	7	-.33	-1.92
Child age	209	7	.16	0.91
d pre treatment	209	7	-.17	-0.99
Number of sessions	209	7	-.51	-2.97**

* $p < .05$. ** $p < .01$. *** $p < .001$.

deviations. Otherwise, the calculation of Cohen's d was based on reported test statistics F , p , or t values. The reported results were transformed into Cohen's d with an effect size determination program (Wilson, 2001a,b).

After calculating the effect size for each single study, combined mean effect sizes were calculated and moderator analyses were conducted, using SPSS macros (Hox, 2002; Wilson, 2001a,b), based on the fixed effect model instead of the random effect model in order to obtain sufficient statistical power, which seemed imperative given the relatively small number of studies included in this meta-analysis. Significance testing in fixed effects models is based on the total number of participants in the meta-analysis, but generalization is limited to other participants who might have been included in the same studies of the meta-analysis. In random effects models, significance testing is based on the total number of studies in the meta-analysis, and results can be generalized to the population of studies from which the current set of studies was drawn (Rosenthal, 1995).

Homogeneity of combined effect sizes, 95% confidence intervals, and analysis of variance were also calculated with the macros provided by Wilson (2001a,b) and Hox (2002). Homogeneity analyses were conducted at $p < .05$ in order to examine whether samples of studies were homogeneous. That is, we identified whether effect sizes were constant across studies, or whether there were differences among effect sizes that could have some source other than the subject-level sampling error, which would be an indication of heterogeneity. These differences may then be associated with different study characteristics (Lipsey & Wilson, 2001, pp. 115–119). Subsequently, the analyses of variance were conducted to examine which particular moderators would explain significant variability within the meta-analytic sample of studies. This analysis of variance (ANOVA) was conducted for the categorical variables (see Durlak & Lipsey, 1991). For the continuous moderator variables, a series of regression analyses was carried out. Outlying effect sizes were identified on the basis of z values larger than 3.3 or smaller than -3.3 ($p < .005$) (Tabachnick & Fidell, 2001).

1.5. Publication bias

A common problem in meta-analysis is that studies with non-significant findings are less likely to be published than those which achieved statistical significance (Rosenthal, 1995). Thus, studies included in any meta-analysis do not form a random sample of all studies conducted on the subject. To inspect whether such possible publication bias exists, it is possible to calculate the fail-safe number, which is the minimum number of additional studies with non-significant results needed to decrease significant meta-analytic results to non-significance (Durlak & Lipsey, 1991). Meta-analytic findings are considered to be robust if the fail-safe number exceeds the critical value obtained with Rosenthal's (1995) formula of $5 * k + 10$: k is the number of studies included in the meta-analysis.

2. Results

Table 1 provides an overview of all studies included in the meta-analysis, together with effect sizes for the individual studies and study characteristics. The 7 studies included in the meta-analysis reported

on $N = 109$ children treated with EMDR and $N = 100$ control group children, with an age range between 4 and 18 years. Mean age of the children in the EMDR group was 10.88 years ($SD = 1.55$). The average sample size for children treated with EMDR was $N = 16$. In three of the seven studies, a majority of the participants was female ($\geq 60\%$). The number of EMDR sessions varied between 3 and 8 (see Table 1). Rubin et al. (2001) reported that the number of sessions was 5 or more.

According to generally accepted conventions, the effect sizes of $d = .20$, $d = .50$ and $d = .80$ were considered as indices of small, medium, and large group differences (Cohen, 1988), whereas the effect sizes of $d = .00$ would indicate that there was no difference between the experimental and control groups. The individual study effect sizes ranged from .07 to 1.45. The overall mean effect size for the effect of EMDR on trauma status at the post-test was $d = .56$, $p < .001$ (see Table 3). No outlying effect sizes were identified. The calculated fail-safe number, 145 (fixed effects model), exceeded Rosenthal's (1995) critical value ($k * 5 + 10 = 45$), which indicated that the number of unpublished studies with non-significant results that would be required to reduce significant results to non-significance was sufficient, indicating no evidence of publication bias.

The mean effect size was found to be heterogeneous: $Q(8) = 33.62$, $p < .001$. Thus, the mean effect size for EMDR in children appears not to be a good representation of the distribution of effect sizes, indicating that differences between the effect sizes might have another source than the subject-level sampling error.

2.1. Continuous moderator analysis

Table 2 provides an overview of the continuous moderator variables, including publication year, percentage of study completers, percentage of girls, mean age of the child, the effect size for trauma at the pretreatment, and the number of sessions, of which three moderators yielded significant standardized regression coefficients. The standardized regression coefficients for year of publication ($b = -.51$, $p < .01$) and percentage of study completers ($b = -.63$, $p < .001$) were significant, indicating that the effect sizes were lower in the more recent studies and the studies with more study completers. The standardized regression coefficient for the number of sessions was also significant ($b = -.51$, $p < .001$), which indicates that fewer sessions were associated with larger post-treatment effect sizes. The standardized regression coefficient for the percentage of girls just failed to reach significance ($b = -.33$, $p = .054$), which indicated a trend showing that studies with an overrepresentation of girls yielded smaller effect sizes.

2.2. Categorical moderator analysis

Table 3 provides an overview of the categorical moderators, including type of the control group, the follow-up, the flexibility of the

Table 3

Categorical moderator analyses comparing children with trauma treated with EMDR to children receiving non-established and established procedures.

Moderator variables	N	k	d	95% CI	Q between	Q within
Overall	209	7	.56***	.42–.70		33.62***
Type of study controls					5.67*	
Non-established	157	5	.66***	.49–.82		27.78***
Established	52	2	.25*	-.04–.54		0.16
Follow-up					1.77	
Yes	93	3	.45***	.24–.66		3.49
No	116	4	.65***	.45–.84		28.35***
Flexibility sessions					0.61	
Flexible	147	5	.52***	.35–.69		32.88***
Not flexible	62	2	.65***	.38–.91		0.13
Type of informant					5.49*	
Child	65	2	.31*	.05–.56		3.40
Parent and child	144	5	.67***	.50–.85		24.73***

* $p < .05$. ** $p < .01$. *** $p < .001$.

treatment sessions, and the type of informant. A series of ANOVAs generated two significant moderators: the type of study controls and the type of informant. The combined effect size for comparisons with children from the non-established control groups – care as usual ($d = .65$) and waiting list control ($d = .67$) – was significantly larger ($d = .66, p < .001$) than the combined effect sizes for comparisons with established trauma treatments ($d = .25, p < .05$). It should be noted, however, that this significant and positive effect size for comparisons between the EMDR and the established trauma treatment (CBT) indicated incremental efficacy of EMDR. The combined effect size for studies assessing PTSD symptoms using both parents and children as informants was significantly larger ($d = .67, p < .001$) than the combined effect size for studies using child report only ($d = .31, p < .05$).

2.3. Multiple regression analysis for predicting unique variance in post-treatment trauma

Variables that were significant in the series of continuous and categorical moderator analyses were entered in a multiple regression equation as predictors of unique variance in the post-treatment trauma effect sizes. These variables included the year of publication, the percentage of study completers, the number of EMDR sessions, the type of informant, and the type of control group (non-established versus established trauma treatment). The regression model was significant, $Q(1, 5) = 31.35, p < .001$. Two variables emerged as significant predictors of post-treatment trauma effect sizes: the percentage of study completers ($b = -.69, p < .01$), and type of control group ($b = -.91, p < .001$).

3. Discussion

The goal of this meta-analysis of EMDR in children with PTSD was to examine whether EMDR is efficacious and, in addition, to examine whether EMDR generates incremental efficacy when compared to other well-established trauma treatments for children. The overall effect size for EMDR was $d = .56$ (medium), which indicates that children receiving EMDR appear to benefit from their treatment, which is in accordance with the results from several meta-analytic studies of EMDR in adult samples (e.g., Bradley et al., 2005; Davidson & Parker, 2001; Van Etten & Taylor, 1998). When the children treated with EMDR were compared to the children treated with established trauma treatments (CBT), EMDR adds a small but significant incremental value.

A higher percentage of study completers proved to be associated with a smaller effect size for EMDR. It is plausible to suggest that studies with a higher rate of completers also include the less successfully treated children. On the contrary, studies with a lower percentage of study completers may report on successful treatments only, neglecting attrition, which could result in unduly large effect sizes (Bradley et al., 2005). In the present meta-analysis, studies with less than 90% study completers yielded an effect size that was .36 larger ($d = .67, p < .001$) than studies with 90% or more study completers ($d = .31, p < .05$). It is therefore important that future studies aim to prevent study attrition as far as possible, and conduct intent-to-treat analysis in order to examine the possible attrition bias if attrition occurs.

This meta-analysis showed that fewer sessions were associated with better treatment outcome, which could be considered in line with the efficiency principle of incremental efficacy. It is not clear; however, which factors underlie the association between the fewer sessions and the greater treatment effectiveness, and subsequently if fewer sessions are causally related to more positive treatment outcomes. The association, for example, might reflect that children with less deeply engraved trauma respond faster to EMDR.

Moderator analyses showed that studies using a combination of parent and child report showed medium-to-large effect sizes, whereas studies using child report yielded small effect sizes. Recently, Meiser-Stedman, Smith, Glucksman, Yule & Dalgleish (2008) found that PTSD

diagnosis was more stable when based on the parent than on the child report. It is therefore possible that the smaller effect sizes for the child report may be due to the less reliable trauma measurement. An alternative explanation is that the multi-informant ratings of trauma are more valid, and thus yield larger effect sizes. We suggest that the parent report is an important aspect in the assessment of trauma-related behaviors, feelings, and emotions (Scheeringa, Wright, Hunt & Zeanah, 2006). It might also be advisable to use the multi-informant report of the trauma symptoms based on both the parent and the therapist-completed measures of trauma, such as the clinical diagnostic interview CAPS-C (Nader, Blake, Kriegler & Pynoos, 1994) or ADIS-C (Silverman & Albano, 1996).

A significant moderator effect was found for year of publication, indicating that the more recent studies had smaller effect sizes for differences between the EMDR and the control groups. This may be caused by two recent studies with the control children receiving established trauma treatment and relatively small effect sizes. In contrast, control children in the older studies received treatment as usual or no treatment, which resulted in relatively large effect sizes.

A trend for the percentage of girls was found, which indicated that that studies including higher percentages of girls yielded smaller effect sizes. This cannot be easily explained. A possible explanation is that girls react more strongly to traumatic events than boys, as there is an evidence to suggest that due to biological differences girls are at higher risk for PTSD symptoms and have greater problems in coping with PTSD symptoms (De Bellis & Van Dillen, 2005; DeBellis, Baum, Birmaher, Keshavan, Eccard & Boring, 1999; Matud, 2004; Nemeroff, Bremner, Foa, Mayberg, North & Stein, 2006). The possible greater vulnerability of girls might imply that the EMDR treatment in girls should be more intensive, requiring more sessions for attaining a non-clinical status.

Reflecting on the current meta-analytic results, it must be noticed that this is the first meta-analysis showing efficacious results for EMDR in children and showing, although tentatively, that the found efficacy is incremental when comparisons involve children receiving CBT treatment. This meta-analysis should, however, be considered as an evaluation of the EMDR research with children over a relatively short time span.

What may this meta-analysis mean for the future status and the research on EMDR in children? The controversy in the debate about EMDR's efficacy seems especially to lie in its claimed efficacy. That is, EMDR's trustworthiness has to date been hampered by the not empirically supported hypothesis that bilateral stimuli are the therapeutic (distinctive) component of EMDR, while research has brought us little confirmative insight into how EMDR works due to lack of replications (Gunter & Bodner, 2008). The present meta-analysis shows that EMDR is moderately effective in reducing PTSD symptoms when EMDR is compared with the treatment as usual or the control groups receiving no treatment, while support for incremental efficacy is found when EMDR is compared with the established trauma treatment.

It could be argued that the incremental efficacy of EMDR may provide some evidence for one of the hypothesized working mechanisms of EMDR, namely, the bilateral stimulation. The EMDR's incremental efficacy might also be explained by all procedural differences (e.g., recurrent short exposure and the freedom for distancing to the traumatic memory) of EMDR when compared to cognitive behavioral therapy, including exposure techniques (Lee, 2008; Rogers & Silver, 2002; Solomon & Shapiro, 2008). Furthermore, besides procedural differences, a number of hypotheses have been posited to explain why EMDR works, such as the working memory account (Gunter & Bodner, 2008) and the hypothesis of an REM sleep state-like condition (Stickgold, 2007). It has also been suggested that EMDR works as a distractor and that through distance the client is enabled to handle the recurrent exposure to the traumatic memory (Rothbaum et al., 2005). To date, the results pertaining to the

investigation of these accounts are inconsistent. The field of neurobehavioral research shows enormous potential to explore bilateral stimulation as an incremental treatment technique and the underlying hypothesized working mechanisms (Solomon & Heide, 2005; Stickgold, 2002, 2007). Finally, the incremental efficacy may be elucidated by taking into account the appropriate research standards for the evaluation of component analyses, such as responsiveness to treatment, large samples for adequate statistical power, and treatment fidelity (Chemtob et al., 2000; Rogers & Silver, 2002; Solomon & Shapiro, 2008). More studies, especially designed to investigate the respective hypotheses and procedural differences, should thus help further inquiry.

The consistent finding of the EMDR's efficacy in both adults and children also points to another direction for future research. As well as the need for further research on the efficacy and the efficiency of trauma treatments, it is as important to study which type of trauma treatment best suits the different types of traumatic events. Because this meta-analysis consists of only 7 studies, we were not able to examine the type of traumatic event, although the initial moderator analyses showed that EMDR is efficacious for children with type I trauma (not all studies consistently rated whether children were treated for type I trauma, type II trauma, or whether samples included children with both types of trauma). It may thus be that children with trauma due to enduring and very deeply engraved trauma, such as sexual abuse, benefit more from the other trauma treatments. For instance, the work of Cohen et al. (2004; 2007) shows the high efficacy of CBT with children experiencing sexual trauma. Adler Nevo and Manassis (2005) have shown that type I trauma is relatively under researched when compared to type II trauma. Children with PTSD symptoms may benefit from the intervention studies that make a distinction between the type I and the type II traumas and the fine-tuning of treatment to these distinct trauma types.

There is a multitude of risk factors that contribute to the development of PTSD symptoms in children. It is imaginable that certain types of treatment are better equipped to treating children sharing the same risk factors (e.g., dissociation or not during the traumatic event, family psychopathology) than other types of treatment. Further examination of the dynamics of risk factors in child PTSD and the attunement of trauma treatment to these factors would contribute to the field of PTSD.

Some limitations of this meta-analytic study should be mentioned. Although the minimum number of studies to permit a meta-analysis is only three studies (Treadwell, Tregear, Reston & Turkelson, 2006) and many published meta-analyses contain nine or fewer studies (Lau, Ioannidis, Terrin, Schmid & Olkin, 2006), the small number of seven studies included in this meta-analytic review limits the generalizability of our findings and the possibilities of examining and adjusting for publication bias by means of more complex analytic methods (Macaskill, Walter & Irwig, 2001). Moreover, all the primary studies that were included into the meta-analysis had small sample sizes. Therefore, the results should be interpreted with great caution. If study sample sizes are relatively small, randomization may not result in equivalence of the contrasted groups. Nevertheless, future studies should strive to enlarge sample sizes, which can be achieved by conducting multi-center research.

As already mentioned, children may improve significantly on PTSD symptoms during treatment, while the effect size for EMDR is a reflection of this improvement. What cannot be concluded is whether or not the children experienced a clinically significant improvement, that is, from a clinical status to a non-clinical status. This may be due to ending the EMDR treatment when desired levels of SUDs and VOCs have been reached. Therefore, it is important that trauma symptoms are not only measured with standardized trauma outcome measures, but that it is reported, on the basis of these outcome measures, whether children have improved in a clinically significant way. As such, statistics for improving and nonimproving children should be provided, as well as whether clinical status (positive or negative) has been reached.

In summary, this meta-analysis of EMDR in children showed that EMDR is efficacious in treating PTSD symptoms. Moreover, we found incremental efficacy of EMDR when compared to established treatment. More multi-center research, with randomized designs and larger sample sizes, is needed to examine whether the current findings can be replicated. Issues of efficacy should in this respect not only pertain to incremental efficacy. Children with PTSD symptoms could benefit from the research on the efficacy of treatments while taking into account distinct types of traumatic events and the multiple factors underlying PTSD development. On the basis of the current meta-analytic results we recommend to further explore EMDR's incremental efficacy in treating children with PTSD symptoms by means of randomized controlled studies. This includes the inquiry of the working mechanisms of EMDR and all procedural differences when compared to cognitive behavioral therapies, with studies especially designed for this purpose.

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