

Review article

Social cognitive performance in posttraumatic stress disorder: A meta-analysis

Petrus G.J. Janssen^{a,b,*}, Leanne A.C. van Est^c, Mirrian Hilbink^b, Loes Gubbels^a, Jos Egger^{d,e,f}, Antonius H.N. Cillessen^a, Elisa van Ee^{a,b}

^a Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

^b Psychotraumacentrum Zuid Nederland, Reinier van Arkel, 's-Hertogenbosch, The Netherlands

^c Department of Developmental Psychology, Faculty of Social Sciences, Utrecht University, Utrecht, The Netherlands

^d Centre of Excellence for Neuropsychiatry, Vincent van Gogh Institute for Psychiatry, Venray, The Netherlands

^e Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands

^f Stevig Specialized and Forensic Care for People with Intellectual Disabilities, Dichterbij, Oostrum, The Netherlands



ARTICLE INFO

Keywords:

PTSD
Social cognition
Mentalization
Emotion recognition
Social perception
Attributional style

ABSTRACT

Background: Social support represents a key factor in the development of post-traumatic stress disorder (PTSD). Social cognition – the ability to perceive, interpret, and respond to other people – is considered fundamental in making use of social support. Gaining knowledge on the link between PTSD and social cognition is therefore essential. Whilst social cognitive difficulties in patients with PTSD are documented, an understanding of which particular social cognitive processes might be affected more than others, is lacking. The current meta-analysis was therefore aimed to examine social cognitive functioning in four underlying social cognitive domains (mentalization, emotion recognition, social perception, and attributional style) in PTSD diagnosed patients versus controls.

Methods: Meta-analyses were conducted on studies examining performance on at least one social cognitive domain in PTSD diagnosed patients compared to controls.

Results: 19 studies were included, involving 565 patients and 641 controls. Relative to controls, the PTSD group scored lower on overall social cognitive functioning ($SMD = -0.42$), specifically on mentalization ($SMD = -0.81$) and social perception ($SMD = -0.30$), whilst the latter should be interpreted with caution as only one study was found pertaining to this domain. No emotion recognition and attributional style differences were found.

Limitations: There was evidence of moderate heterogeneity in the results of the included studies for overall social cognition and attributional style.

Conclusions: Findings indicate that social cognition represents a potential important clinical factor in PTSD and underscore the importance of differentiating between underlying social cognitive processes in research and treatment of PTSD.

1. Introduction

Social support represents a key factor in the development of post-traumatic stress disorder (PTSD) – characterized by intrusive thoughts or flashbacks, avoidance of trauma-related stimuli, negative alterations in mood and cognitions, and hyperarousal features (American Psychiatric Association, 2013). Social support can act as a buffer, as it can enhance coping with stress responses following trauma. Indeed, a lack of social support reflects a major risk factor for PTSD as shown in two

meta-analyses (Brewin et al., 2000; Ozer et al., 2003). Additionally, studies have shown that a lack of social support is linked to the maintenance of PTSD (Dirkzwager et al., 2003; Schnurr et al., 2004). Evidence hence indicates that social support plays a central role in PTSD.

Whilst the role of social support in traumatized individuals is well-established, it is less well understood if and how PTSD in turn affects the use of social support. It is plausible that the symptoms of PTSD itself, such as negative alterations in mood and cognition, decrease the ability to perceive, interpret, and respond to other people. These abilities –

* Corresponding author at: Behavioural Science Institute, Radboud University Nijmegen, Thomas van Aquinostraat 4, Nijmegen, The Netherlands.

E-mail address: Peter.janssen2@bsi.ru.nl (P.G.J. Janssen).

<https://doi.org/10.1016/j.jad.2021.09.082>

Received 21 March 2021; Received in revised form 16 September 2021; Accepted 26 September 2021

Available online 1 October 2021

0165-0327/© 2021 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

collectively falling under the definition of *social cognition* (Green et al., 2008) – are considered fundamental in effectively making use of social support (Sharp et al., 2012). Social cognitive processes can be subdivided into four domains (Green et al., 2008). These include the interpretation of behavior of others based on their mental states (*mentalization* or *theory of mind*); the identification and recognition of emotional states from social stimuli (*emotion recognition*); the recognition of social regulations, rules, and goals in social situations (*social perception*); and the explanation of social situations (*attributional style*). To understand how patients diagnosed with PTSD can use social supportive signals more effectively, it seems essential to further understand the association between PTSD and different social cognitive domains – representing the primary goal of this study.

1.1. The association between PTSD and social cognitive domain functioning

Research suggests that core PTSD features like emotional dysregulation, emotional numbness, and feelings of interpersonal detachment may be accompanied by an inability to adequately perceive and infer social information (e.g. Lavoie et al., 2014; Mazza et al., 2012; Stevens and Javanovic, 2019).

Particularly, PTSD diagnosed individuals depict emotion dysregulation problems (Boden et al., 2013; Ehring and Quack, 2010; Shepherd and Wild, 2014), involving an inability to process emotional cues such as recognizing others' emotional expressions (Passardi et al., 2018; Poljac et al., 2011; Schmidt and Zachariae, 2009; Steuwe et al., 2014). As such, Poljac et al. (2011) compared war veterans with PTSD to a matched control group and found that traumatized veterans were less accurate in recognizing certain facial emotional expressions (fear and sadness) during a computerized emotion recognition task. Passardi et al. (2018) also found that the recognition of positive emotional expressions was impaired in a PTSD sample, in which larger impairments were linked to a higher number of reported traumatic events and moderate levels of trauma related dissociation. The latter converges with evidence showing that PTSD symptomatology, such as increased levels of dissociation, are associated with decreased performance on social cognitive tasks, including emotion recognition tasks (Nazarov et al., 2015; Nazarov et al., 2014).

Moreover, ample studies indicated decreased performances on mentalization tasks (e.g., Mazza et al., 2012; Mazza et al., 2015; Nazarov et al., 2014). PTSD related mentalization problems are for instance evidenced by PTSD diagnosed military police officers performing less compared to healthy participants in a task in which they had to describe what another person might feel in certain emotional contexts (Mazza et al., 2012). These authors also found that social cognition deficits were predicted by avoidance and numbing symptoms and they accordingly formulate that “central symptoms of PTSD as avoidance/emotional numbness or social withdrawal and emotional paralysis may underlie a deficit in the acquired inability to understand others' mental states and to understand/share emotions with others” (p. 254).

Furthermore, cognitive models of PTSD (Ehlers and Clark, 2000) postulate that traumatized individuals are biased towards appraising environmental social cues as negative and threatening. To illustrate, Elwood et al. (2007) studied how victims and non-victims of interpersonal violence interpret short videos of social scenes. Results indicated that victims perceived positive valenced videos as risky and threatening videos as more likely to escalate to threat, as compared to non-victims. The latter finding is supported by accumulating evidence showing biased attributional processing in traumatized individuals (e.g., Boffa et al., 2018; Elwood et al., 2007; Kimble et al., 2012).

Lastly, a narrowly oriented attention bias towards social threat might impair the processing and interpretation of various contextual cues (Bomyea et al., 2017; Naim et al., 2015), which is considered essential in social perception (Green et al., 2008). Taken together, previous work indicates that patients with PTSD show difficulties in different domains

of social cognition.

1.2. The current study

Whilst social cognitive difficulties in patients with PTSD are documented, an understanding of which particular domains might be affected more than others, is still lacking. To our best knowledge, only Lavoie et al. (2014) compared functioning on all four domains in PTSD and other anxiety disorder groups versus non-clinical controls. They assessed studies on social cognition in PTSD and findings indicated deficits in the domains of mentalization and emotion recognition, suggesting that different social cognitive processes might be differentially affected in PTSD. Addressing domain functioning in PTSD is relevant, as it will inform which specific social cognitive processes should be targeted clinically, which may then help traumatized individuals to perceive and use social support more effectively, as a protective factor against PTSD symptomatology. Moreover, interventions targeting specific social cognitive processes are shown to be more effective compared to broad-based or comprehensive interventions, that target multiple social cognitive processes (see Roelofs et al. 2016 for a meta-analysis). Social cognitive aspects may also be targeted through preventive practices. Specifically, as conceptualized by the latent-vulnerability model (McCrory and Viding, 2015), already existing problems in social cognition – for instance due to early maltreatment which may distort the perceptions of oneself and others (see also Sharp et al., 2012) – may represent a latent vulnerability factor suited for prevention programs insofar as problems with social cognition may complicate the use of social support following traumatic experiences later in life, potentially increasing the risk for developing manifest clinical conditions such as PTSD.

The aim of the current review was to examine functioning among traumatized individuals diagnosed with PTSD in the four social cognitive domains. Domain functioning was compared to non-clinical controls using a meta-analytic approach. In line with previous work, we hypothesized that the PTSD group will demonstrate deficits in all four domains compared to non-clinical controls. Hypotheses about the degree as to which domains were more affected than others in terms of effect sizes were exploratory of nature.

2. Method

This study was conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

2.1. Eligibility criteria

Articles eligible for inclusion were: (1) English written peer-reviewed articles, (2) that reported or provided data on request to calculate between-group standardized mean difference (SMD) estimates (i.e., sample size, means, and standard deviations), (3) in which the task performance was compared on at least one social cognitive domain, (4) between two adult age groups (≥ 18 years old) including one clinical group primarily diagnosed with PTSD based on formal criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III, DSM-VI, DSM VI-R, DSM-5; American Psychiatric Association, 2013) versus a control group without such a diagnosis.

In line with Lavoie et al. (2014), social cognitive domain tasks were operationalized as follows. In *mentalization* or *theory of mind* (TOM) tasks, mental states or beliefs of a target person were identified or inferred (response based on information about both the target person and the context). For example, in the Strange Stories test (Mazza et al., 2012), short stories describing emotional situations were presented in which participants were instructed to infer what the target person might feel given the defined context.

Emotion recognition tasks involve the identification or discrimination

of emotional states (response based on information of a target person without any contextual information). For example, emotional states were identified based on facial expressions (e.g., [Steuwe et al., 2014](#)), vocal cues (e.g., [Nazarov et al., 2015](#)), or eye regions (e.g., [Mazza et al., 2012](#); [Nazarov et al., 2014](#)).

Social perception tasks included the detection of social roles, rules, or goals that characterized particular social situations (response based on contextual information). For example, the Interpersonal Perception Task-15 ([Nazarov et al., 2014](#)) consisted of short vignettes of social interactions accompanied by objective multiple-choice questions concerning the interactions (e.g., judging the relationship between two interacting people as “acquaintances” or “lovers for four years”).

Attributional style tasks measured how participants tended to explain events. There were two types of attribution tasks. First, tasks indicating whether participants assessed social events as positive or negative (e.g., rating the valence of hypothetical events such as thinking of the moment that “a past memory suddenly comes to mind”; e.g., [Boffa et al., 2018](#)). Second, tasks measuring to what extent hypothetical events were explained according to a depressive bias style, in which events were attributed to internal, stable, and global causes ([Gray et al., 2003](#); [McCormick et al., 1989](#)).

2.2. Search strategy

A literature search was executed on July 15, 2021 using the electronic databases Ovid MEDLINE, PsycINFO, Embase, Web of Science, Pubmed, and PTSDpubs (PILOTS). Searches in all databases were conducted from inception to July 15, 2021. The following search terms were employed: “PTSD”, “posttraumatic stress disorder”, “post traumatic stress disorder”, “post-traumatic stress disorder”, or “trauma” combined with “social cogn*”, “mentali*”, “theory of mind”, “theory-of-mind”, “TOM”, “perspective taking”, “perspective-taking”, “reflective function*”, “mental state attribution”, “emotion recognition”, “emotion perception”, “emotion processing”, “emotion identification”, “emotion discrimination”, “emotion labeling”, “facial affect”, “affect recognition”, “affect perception”, “affect processing”, “affect identification”, “affect discrimination”, “affect labeling”, “social perception”, “social knowledge”, “social rule*”, “social cue*”, “social norm*”, “social goal*”, “attributional style”, “attribution bias”, “interpretation bias”, “interpretation style”, or “explanatory style”. Additionally, reference lists of included articles were screened to identify additional articles for inclusion.

2.3. Data extraction

The first and second author independently screened the titles and abstracts of all retrieved articles for possible inclusion. Potentially eligible articles were evaluated full-text using the inclusion criteria. Disagreements were resolved through discussion and if this was not possible by consultation with the last author. The following information was extracted from all included articles: authors; year of publication; title; sample size, age, and gender composition of the PTSD group and the control group; social cognitive domain(s); tasks used; and task outcome data (M and SD) to calculate between-group standardized mean differences (SMD).

2.4. Data analysis

Review Manager 5 software (Version 5.3, The Nordic Cochrane Centre, Copenhagen, Denmark) was used to conduct meta-analyses and to generate forest plots. $SMDs$ including 95% confidence intervals (CI) were calculated using a random effects model in which the SMD represented the between-group mean difference divided by the pooled standard deviation. $SMDs$ were weighted using the inverse variance method. $SMDs$ were interpreted as small (0.2–0.5), moderate (0.5–0.8), or large (>0.8) based on [Cohen \(2013\)](#).

Five pooled SMD estimates were calculated: one for each social cognitive domain separately and one for all four domains combined. If needed, $SMDs$ were inverted to ensure that a negative SMD signified lower PTSD performance relative to controls. For studies utilizing more than one measure to assess the same domain (e.g., two mentalization tasks were used in [Mazza et al., 2012](#)), those measure outcomes were pooled before analyzes, resulting in a single domain estimate per study. When task outcomes were not presented as a total score, but as several subscale scores (e.g., recognition rates of happy, fearful, and angry faces in [Bell et al., 2017](#)), those subscale scores were also pooled before analyzes. When studies examined multiple control groups – for instance, comparing a mission related PTSD group versus both with/without mission exposed control groups without PTSD ([Mazza et al., 2012](#)) – the control group that corresponded the most to the PTSD group was included in the analyzes (i.e., mission exposed without PTSD).

Between-study statistical heterogeneity was analyzed using the χ^2 test of significance and the I^2 statistic. The I^2 statistic indicates the percentage of variance between studies that is due to differences between studies rather than chance ([Higgins et al., 2003](#)). The degree of heterogeneity was interpreted as low ($I^2 = 25\%$), moderate ($I^2 = 50\%$) or substantial ($I^2 = 75\%$). When study outliers – defined as when a study’s confidence interval did not overlap with the overall pooled effect – appeared, they were excluded and analyzes were run again ([Viechtbauer and Cheung, 2010](#)).

3. Results

3.1. Study selection

A flowchart of the selection process is shown in [Fig. 1](#). The literature search yielded 2262 records. The references of these studies yielded eight additional records. When duplicates were removed 1734 records remained. Of these, 1684 records were excluded based on title and abstract. The full text of the remaining 50 records was examined. Of these, 19 studies met the inclusion criteria and were included in this meta-analysis.

3.2. Study characteristics

The characteristics of the 19 studies are shown in [Table 1](#). Together, they included 565 participants in the PTSD condition ($M_{age} = 37.72$ years \pm 10.08; 42% males) and 641 participants in the control condition ($M_{age} = 36.21$ years \pm 10.40; 51% males). The PTSD samples included different types of trauma history, including war-related combat (e.g., [Gebhardt et al., 2017](#); [Mazza et al., 2012](#)), childhood abuse ([Nazarov et al., 2014](#); [Nazarov et al., 2015](#); [Steuwe et al., 2014](#)), exposure to natural disasters ([Bell et al., 2017](#); [Mazza et al., 2015](#)), interpersonal violence ([Fonzo et al., 2010](#)), and a combination of types (e.g., physical assault, sexual assault, accidents; [Boffa et al., 2018](#); [Fertuck et al., 2016](#); [Janke et al., 2018](#)). Emotion recognition was studied most frequently (10 studies: [Bell et al., 2017](#); [Fonzo et al., 2010](#); [Mazza et al., 2012](#); [Nazarov et al., 2014](#); [Nazarov et al., 2015](#); [Nietlisbach et al., 2010](#); [Passardi et al., 2018](#); [Schmidt and Zachariae 2009](#); [Simmons et al., 2011](#); [Steuwe et al., 2014](#)), followed by attributional style (six studies: [Boffa et al., 2018](#); [Fertuck et al., 2016](#); [Gebhardt et al., 2017](#); [Allred et al., 2018](#); [McCormick et al., 1989](#); [Solomon et al., 1991](#)), mentalization (five studies: [Janke et al., 2018](#); [Mazza et al., 2012](#); [Mazza et al., 2015](#); [Nietlisbach et al., 2010](#); [Palgi et al., 2016](#)), and social perception (one study: [Nazarov et al., 2014](#)).

3.3. Meta-analytic results

Meta-analyses were conducted to analyze between-group differences on overall social cognition, mentalization, emotion recognition, and attributional style in PTSD diagnosed versus controls. It was not possible to run a meta-analysis for social perception, as only one study was found

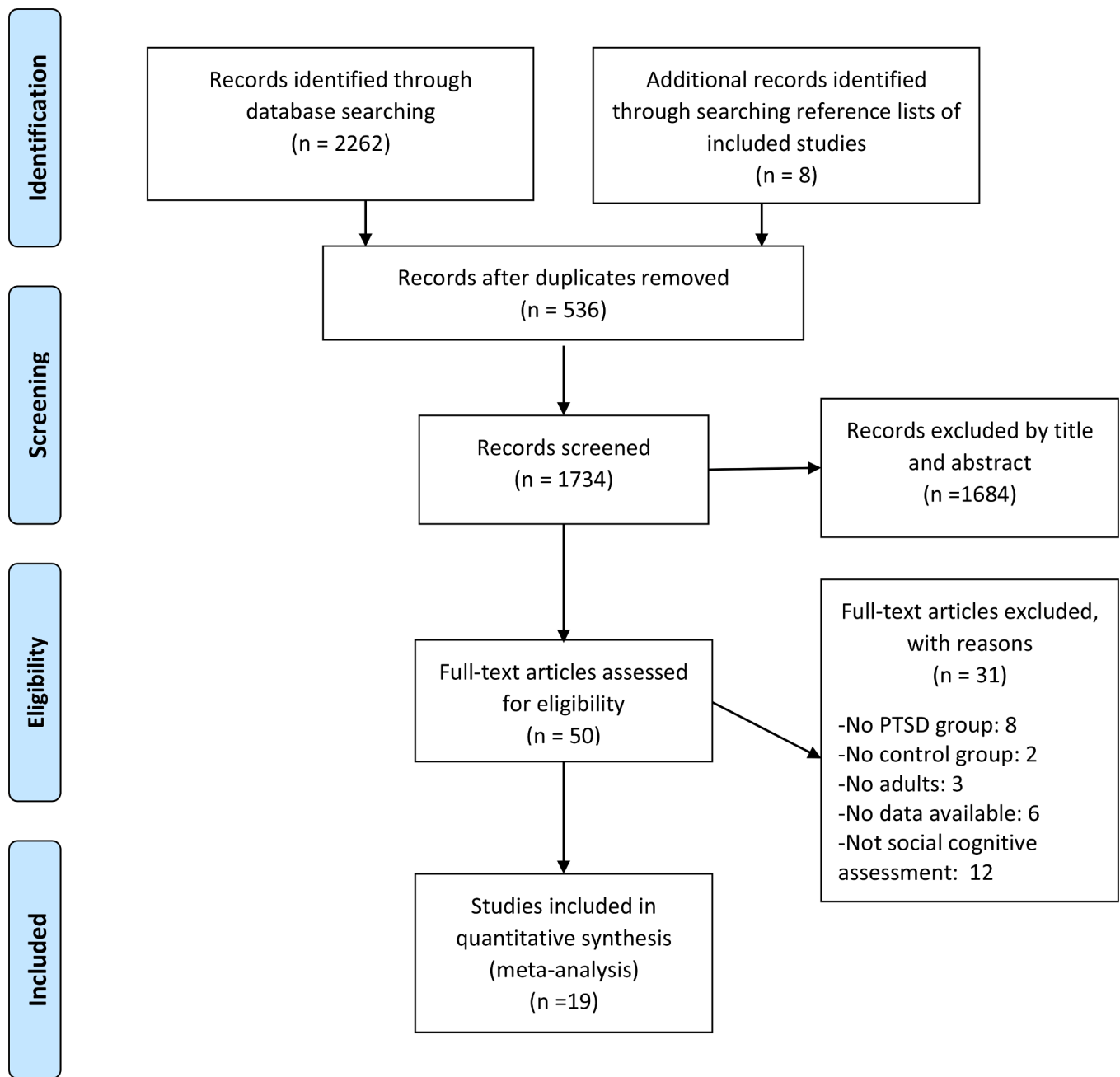


Fig. 1. PRISMA flowchart of the selection process of included studies.

in this domain.

3.3.1. Overall social cognitive performance

Overall social cognitive performance (i.e. mentalization, emotion recognition, attributional bias, social perception combined) was significantly lower in the PTSD diagnosed group compared to the controls with a moderate *SMD* of -0.60 , 95% CI $[-0.86, -0.33]$, $p < .001$. Significant and substantial heterogeneity was observed, $T^2 = 0.29$, $\chi^2(21) = 98.96$, $p < .001$, $I^2 = 79\%$. Four study outliers (Boffa et al., 2018; emotion recognition in Mazza et al., 2012; Schmidt and Zachariae 2009; Solomon et al., 1991) were removed as the CIs of these studies and the overall estimate did not overlap. Overall, the significant lower social cognitive performance of the PTSD diagnosed group versus the control group with a moderate *SMD* of -0.42 remained, 95% CI $[-0.62, -0.22]$, $p = <.001$, and significant moderate heterogeneity was found, $T^2 = 0.09$, $\chi^2(17) = 35.21$, $p < .001$, $I^2 = 52\%$. Results for overall social

cognitive performance are shown in Fig. 2.

Post-hoc analyzes were executed to assess whether effect sizes and particularly the accompanied moderate level of between-study heterogeneity varied as a function of differences in trauma type, age and gender across studies. Whilst such analyzes are argued to require large number of included studies (e.g., Tabachnick et al., 2007), these were still performed for exploratory reasons. Firstly, the included 19 studies were analyzed in terms of trauma type and as such grouped into “interpersonal trauma” studies (childhood abuse, physical or sexual abuse: Fertuck et al., 2016; Fonzo et al., 2010; Janke et al., 2018; Nazarov et al., 2015; Nazarov et al., 2014; Nietlisbach et al., 2010; Passardi et al., 2018; Steuwe et al., 2014) and “war” studies (Bell et al., 2017; Gebhardt et al., 2017; Mazza et al., 2012; Mazza et al., 2015; McCormick et al., 1089; Palgi et al., 2016; Simmons et al., 2011) based on their sample descriptions (see Table 1). Effect sizes for both subgroups yielded a significant and moderate *SMD* (“interpersonal trauma” group: *SMD* of

Table 1
Study characteristics.

Study	Trauma type(s)	N PTSD/ C	M(SD)Age PTSD/C	%men PTSD/C	Social cognitive domain(s)	Task(s)	SMD (95% CI)
Mazza, Tempesta et al., 2015	Earthquake exposure	7/10	34.0(9.38)/ 31.7(10.3)	100/50	Mentalization	Multifaceted empathy test	-0.62 [-1.61, 0.38]
Janke et al., 2018	Various (physical assault: 56%; childhood abuse: 54%)*	41/63	34.8(10.6)/ 39.2(10.7)	17.1/ 36.5	Mentalization	Test of Emotional Intelligence	-0.85 [-1.26, -0.44]
Palgi et al., 2016	Various (war: 41%; traffic accidents: 28%)*	32/30	43.44 (11.4)/ 39.87(18.9)	28.1/ 63.3	Mentalization	Compassion task	-1.13 [-1.67, -0.59]
Mazza et al., 2012	War	20/15	41.13(4.8)/ 41.93(4.9)	100/100	Mentalization; Emotion recognition	Strange stories task, emotion attribution task; Reading mind in the eyes task	-2.48 [-3.39, -1.57]; -1.26 [-2.00, -0.52]
Nietlisbach et al., 2010	Various (interpersonal trauma: 81%; accidental trauma or natural catastrophe: 20%)*	16/16	43.7(14.8)/ 30.0(8.23)	50/50	Mentalization; Emotion recognition	Faux pas; Reading mind in the eyes task	-0.60 [-1.32, 0.11]; -0.29 [-0.99, 0.41]
Steuwe et al., 2014	Childhood abuse	16/16	33.6(11.6)/ 30.6(12.6)	0/0	Emotion recognition	Facial emotion recognition task	-0.57 [-0.86, -0.33]
Simmons et al., 2011	War	12/12	32.2(6.9)/ 28.7(4.5)	100/100	Emotion recognition	Emotional face matching task	0.09 [-0.26, 0.31]
Bell et al., 2017	Earthquake exposure	28/89	42.8(12.8)/ 50.1(11.4)	28.6/ 35.0	Emotion recognition	Facial emotion recognition task	-0.17 [-0.60, 0.25]
Nazarov et al., 2015	Childhood abuse	29/21	42.0(12.3)/ 39.9(14.7)	0/0	Emotion recognition	Affective prosody battery	0.22 [-0.34, 0.78]
Passardi et al., 2018	Various (interpersonal trauma: 95%; undefined: 5%)*	39/44	38.7(12.8)/ 36.5(12.0)	25.6/ 34.0	Emotion recognition	Amsterdam Dynamic Facial Expression Set	-0.23 [-0.66, 0.20]
Fonzo et al., 2010	Intimate-Partner Violence	12/12	35.0(8.6)/ 37.0(6.49)	0/0	Emotion recognition	Emotional face matching task	-0.33 [-1.13, 0.48]
Schmidt and Zachariae 2009	War	16/16	44.1(7.9)/ 36.5(8.4)	50/50	Emotion recognition	Reading mind in the eyes task	-1.66 [-2.48, -0.84]
Nazarov, Frewen, Parlar et al. 2014	Childhood abuse	31/20	42.1(12.0)/ 35.8(13.2)	0/0	Emotion recognition; Social perception	Reading mind in the eyes task; Interpersonal perception task	0.03 [-0.53, 0.60]; -0.82 [-1.41, -0.23]
Boffa et al., 2018	Various (sexual assault: 27%; physical assault: 21%)*	23/23	33.97 (11.9)/32.0 (9.8)	39.1// 66.67	Attributional style	Interpretation bias index for PTSD	-2.44 [-3.22, -1.67]
Gebhardt et al., 2017	War	53/53	35.4(8.6)/ 36.0(10.2)	100/100	Attributional style	Similarity task	-0.60 [-0.99, -0.21]
Fertuck et al., 2016	Various (Physical abuse: 48%; sexual trauma 41%)*	29/19	33.2(10.3)/ 41.2(13.2)	34.5/ 38.9	Attributional style	Trust-fear facial discrimination task	0.24 [-0.34, 0.82]
McCormick et al., 1989	War	26/73	NA(NA)/ NA(NA)	100/100	Attributional style	Attributional style questionnaire	-0.42 [-0.87, 0.03]
Solomon et al., 1991	War	144/73	NA(NA)/ NA(NA)	NA/NA	Attributional style	Causal attributions questionnaire	0.02 [-0.26, 0.31]
Allred et al., 2018	Undefined	7/52	37.14 (9.21)/ 28.42(7)	NA/ 78.8%	Attributional style	Attributions of criticism scale	-0.28 [-1.07, 0.51]

Note. Abbreviations: PTSD = posttraumatic stress disorder, C = controls, SMD = standardized mean difference, CI = confidence interval.

* For clarity, the two mostly assessed trauma types of these studies are described here, as these studies included many trauma types (e.g., up to nine in Boffa et al., 2018). A full description of the assessed trauma types can be found in these studies (Boffa et al., 2018; Fertuck et al., 2016; Janke et al., 2018; Nietlisbach et al., 2010; Passardi et al., 2018).

-0.33, 95% CI [-0.60, -0.05], $p = .02$; “war trauma” group: SMD of -0.59, 95% CI [-0.92, -0.26], $p < .001$ and a significant level moderate heterogeneity (“interpersonal trauma” group: $I^2 = 53%$, $p = .03$; “war trauma” group: $I^2 = 57%$, $p = .003$). Subgroups did not differ significantly from each other ($\chi^2[1] = 1.42$, $p = .23$). Next, gender (operationalized as percentage males across studies) and age were also neither predictive for all included studies, nor when studies were grouped according trauma type (all p 's $> .05$). Taken together, whilst based on a small number of included studies, post-hoc analyzes suggest that the SMD and the degree of heterogeneity of overall social cognition is not affected by trauma type, gender, and age.

3.3.2. Mentalization

Five of the 19 studies compared mentalization between PTSD diagnosed and controls (Janke et al., 2018; Mazza et al., 2012; Mazza et al., 2015; Nietlisbach et al., 2010; Palgi et al., 2016). Mentalization performance was significantly lower in the PTSD group relative to controls with a large SMD of -0.87, 95% CI [-1.17, -0.57], $p < .001$. No significant evidence for heterogeneity was found, $T^2 = 0.02$, $\chi^2(4) = 4.87$,

$p = .30$, $I^2 = 18%$. No study outliers were found. Results for mentalization are shown in the panel A of Fig. 3.

3.3.3. Emotion recognition

Ten of the 19 studies compared emotion recognition between PTSD diagnosed versus controls (Bell et al., 2017; Fonzo et al., 2010; Mazza et al., 2012; Nazarov et al., 2014; Nazarov et al., 2015; Nietlisbach et al., 2010; Passardi et al., 2018; Schmidt and Zachariae, 2009; Simmons et al., 2011; Steuwe et al., 2014). Emotion recognition performance was significantly lower in the PTSD group compared to controls with a moderate SMD of -0.51, 95% CI [-0.93, -0.09], $p = .02$. There was significant and substantial heterogeneity, $T^2 = 0.34$, $\chi^2(9) = 39.62$, $p < .001$; $I^2 = 77%$. Two study outliers (Mazza et al., 2012; Schmidt and Zachariae, 2009) were removed as the CIs of these two studies and the overall estimate did not overlap. The remaining between-group estimate of emotion recognition was not significant, $SMD = -0.17$, 95% CI [-0.37, 0.03], $p = .10$. No significant evidence for heterogeneity was found, $T^2 = 0$, $\chi^2(7) = 5.59$, $p = .59$, $I^2 = 0%$. Results for emotion recognition are shown in the panel B of Fig. 3.

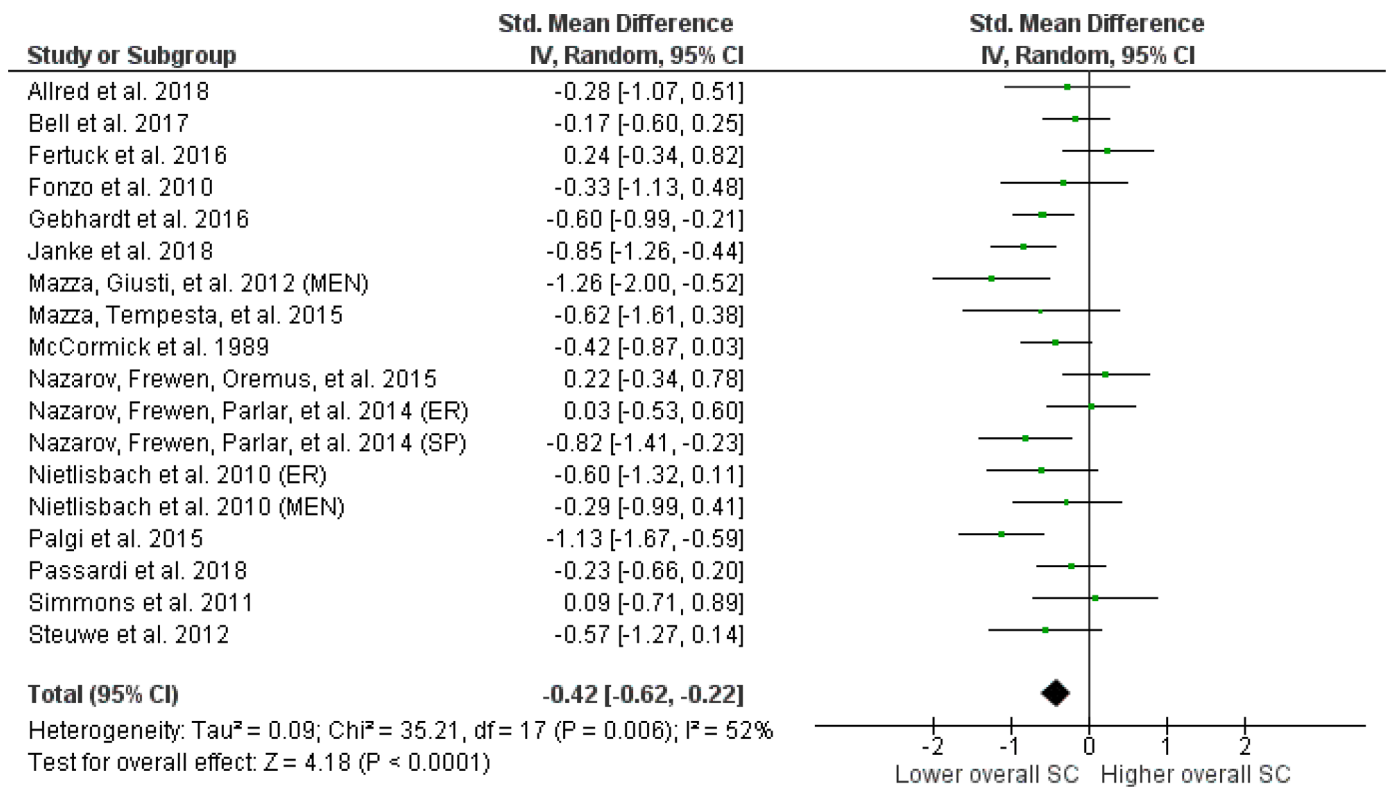


Fig. 2. Forest plot showing differences in overall social cognitive functioning between PTSD and non-clinical controls, excluding four study outliers (Boffa et al., 2018; emotion recognition in Mazza et al., 2012, Schmidt and Zachariae 2009, Solomon et al., 1991), as the CI's of these studies and the overall estimate did not overlap.

3.3.4. Attributional style

Six of the 19 studies compared attributional style between PTSD diagnosed and controls (Boffa et al., 2018; Gebhardt et al., 2017; Fertuck et al., 2016; Allred et al., 2018; McCormick et al., 1989; Solomon et al., 1991). A marginally significant between-group difference was found in attributional style, in which the PTSD group yielded a negative interpretation bias denoted by a moderate SMD of -0.53, 95% CI [-1.09, 0.03], p = .06. Significant and substantial heterogeneity was observed, T² = 0.41, χ²(5) = 40, p < .001, I² = 87%. One study outlier (Boffa et al., 2018) was removed as the CI of this study and the overall estimate did not overlap. The remaining between-group estimate of attributional style was not significant, SMD = -0.21, 95% CI [-0.53, 0.10], p = .19, and significant moderate heterogeneity was found, T² = 0.07, χ²(4) = 9.56, p = .05; I² = 58%. Results for attributional style are shown in panel C of Fig. 3.

3.3.5. Social perception

One of the 19 studies compared social perception between PTSD diagnosed and controls (Nazarov et al., 2014). This study reported a significant lower social perception performance in PTSD diagnosed participants compared to controls with a moderate SMD of -0.30, 95% CI [-0.62, 0.02].

4. Discussion

The aim of this meta-analysis was to examine overall social-cognitive functioning and performance differences on four underlying social cognitive domains (mentalization, emotion recognition, social perception, attributional style) in PTSD compared to controls. As expected, the analyzes demonstrated a deficit with a medium effect size for overall social cognition in the PTSD group compared to controls, not varying as a function of trauma type (comparing studies involving samples exposed to mostly war trauma versus interpersonal trauma), gender or age as

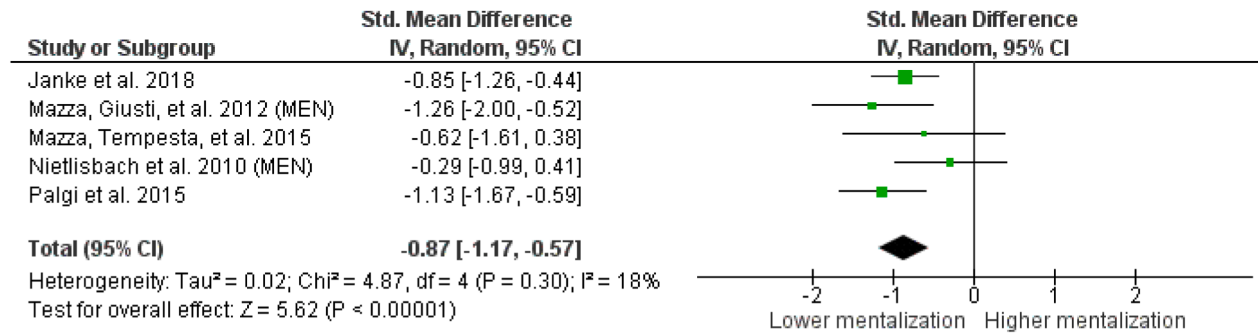
suggested by the results of the post-hoc analyzes. It should be noted that post-hoc analyzes were conducted for explorative reasons as they were probably underpowered. A moderate amount of between-study heterogeneity was found with respect to overall social cognition. The latter could potentially be a consequence of the notion that social cognition represents an overarching construct that is built on separate yet related underlying domains. Put differently, it could hence support the idea that probing partitioned social cognitive domains in PTSD – which is our primary study interest – might be essential. To this end, our hypothesis with respect to observing impaired domain functioning in PTSD was only partially supported. The PTSD group displayed lower performances with large effect sizes for mentalization and social perception, yet the latter should be interpreted with caution as only one study pertaining social perception was found. No group differences were found for emotion recognition and attributional style. When overall social cognition was partitioned into four domains, only the latter domain showed heterogenous study findings (which is elaborated on below).

4.1. Social cognitive functioning and domain performances

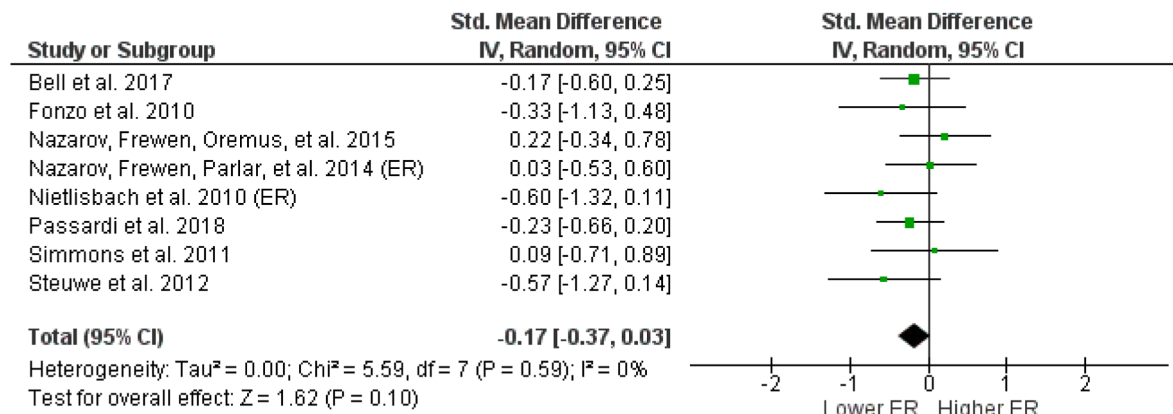
Given that overall social cognitive performance was lower in the PTSD group and that social cognitive skills might be considered vital in the ability to perceive and respond to social support – a well-documented protective factor for the PTSD development (Brewin et al., 2000; Ozer et al., 2003) – our findings underscore that social cognition is an important clinical target in PTSD (Sharp et al., 2012). To target PTSD related social cognitive deficits effectively, it is key to identify which specific social cognitive domains are affected.

Accordingly, our results revealed that the ability to mentalize was impaired in PTSD versus controls, which converges with existing evidence (Mazza et al., 2012; 2015; Nazarov et al., 2014). On the one hand, problems in mentalizing may be explained by the PTSD symptom profile. Specifically, evidence suggests that core PTSD symptoms, such as

A.



B.



C.

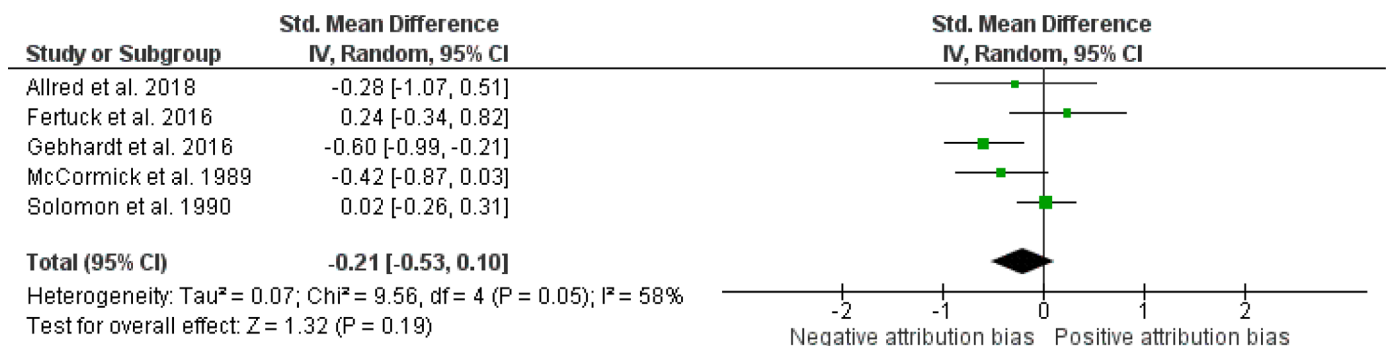


Fig. 3. Forest plots showing differences in mentalization (A), emotion recognition (B), and attributional style (C), between PTSD and non-clinical controls. Two study outliers on emotion recognition (Mazza et al., 2012; Schmidt and Zachariae, 2009) and one on attributional style (Boffa et al., 2018) were excluded from the forest plots, as the CI's of these studies and the overall estimate did not overlap. No study outliers were found on mentalization.

emotional numbing, being emotionally unresponsive and feelings detached from others (American Psychiatric Association, 2013), can potentially make it difficult to process and integrate social information (Mazza et al., 2012; Lavoie et al., 2014). Indeed, Mazza et al. (2012) for instance depicted that social cognition deficits were predicted by avoidance and numbing symptoms. Furthermore, neuroimaging findings showed that PTSD symptoms and impaired mentalization are linked to overlapping disrupted brain regions, including hyperactive amygdala reactivity and a less activation in the medial prefrontal cortex (Pitman et al., 2012; Zoladz and Diamond, 2013). These neuroimaging findings further strengthen the idea that mentalization might be explained as a consequence of PTSD symptomatology. On the other hand, problems with the ability to infer self and others' behavior based on mental states

might be seen as a predisposing factor placing individuals at risk of developing PTSD symptomatology following trauma. For instance, in their social cognitive model of PTSD, Sharp et al. (2012) postulate that, based on experiences with attachment figures, individuals build attachment schemes that helps to understand the self and others. As such, insecure attachment patterns can result in basic negative reflections of the self and others, which is proposed to adversely affect social cognitive capacities. The latter subsequently make it difficult for an individual to make use of social support, potentially increasing the risk for developing PTSD following trauma (Sharp et al., 2012). In line with the latent-vulnerability model (McCrory and Viding, 2015), social cognitive deficits such as problems with mentalization may hence pose a latent vulnerability factor for developing psychiatric symptoms

following trauma later in life. Taken together, current findings point out that PTSD is accompanied by a mentalization deficit, yet follow-up research has to determine the direction of causality between these two constructs.

Our findings further demonstrated a diminished social perception ability in PTSD relative to controls. However, these results must be interpreted with caution as only one study was found for this domain. The finding nevertheless suggests that traumatized individuals experience problems in perceiving and understanding their social context, emphasizing the importance of future research on PTSD and social perception. Processing various contextual cues is suggested to be impaired due to a narrowly oriented attentional bias to environmental threat (Bomyea et al., 2017; Naim et al., 2015). Addressing the latter is relevant; given that studies have shown that a lack of perceived social support is related to PTSD symptom severity (Hofman et al., 2016; Jankowski et al., 2004).

Contrasting our hypothesis, no emotion recognition impairment was found in the PTSD group. This is consistent with some studies (e.g., Bell et al., 2017; Nazarov et al., 2014; Simmons et al., 2011), but diverges from others (e.g., Poljac et al., 2011; Steuwe et al., 2014; Schmidt and Zachariae 2009). However, these latter studies mostly incorporated individuals with interpersonal trauma (e.g., childhood abuse, interpersonal combat). It may be that these clinical groups – given their trauma aetiology – respond differently to the social-emotional cues that were used in the emotion recognition tasks. Another explanation for finding no emotion recognition deficit might be that in some traumatized samples exposure to traumatic events or threatening situations lead to no reduced or even enhanced emotion recognition. For example, Masten et al. (2008) showed that maltreated children showed faster emotion recognition capabilities, interpreted as being functional for detecting threat in dangerous environments. Our current findings thus suggest no emotion recognition deficit in PTSD, but future studies should determine to what extent the recognition of emotional states depends on trauma aetiology.

Finally, the PTSD group did not differ in attributional style from controls. This was not anticipated, as cognitive models of PTSD predict that ambiguous stimuli or events are interpreted negatively (Ehlers and Clark, 2000) and biased processing is likely to be disorder-specific (e.g., van den Heuvel et al. 2005). One explanation for the lack of a difference may thus be that the included studies primarily examined causal explaining of *general* events. However, it may be essential to investigate *trauma-specific* causal attributions in PTSD (Gonzalo et al., 2012). Indeed, several studies have shown that internal, global, and stable attributions of particular traumatic events were associated with PTSD symptoms (e.g., Gray et al., 2003; Wenninger and Ehlers, 1998). For example, it has been consistently shown that internally focused self-blame attributions following sexual assault were related to PTSD symptom development (e.g., Berman et al., 2018; Boeschen et al., 2001; Filipas and Ullman 2006; Najdowski and Ullman 2009). Trauma-specific attributions was also shown to be more predictive of PTSD symptoms compared to a more broad-based dispositional attribution style (Gray et al., 2003). The focus on trauma-specific attributions may also explain why only Boffa et al. (2018) reported a negative attributional bias with a large effect size in PTSD, as this was the only study that used a PTSD specific measure of attributional style. Future research should further explore the role of general versus trauma-specific attributions in PTSD.

4.2. Limitations

The main limitation reflects that there was evidence of moderate heterogeneity in the results of the included studies for overall social cognition, which might be explained by between-study variability of the studies examining attributional style, as only this domain showed a moderate level of heterogeneity after social cognition was partitioned into four domains. Heterogeneous findings on attributional style might be a consequence of variations in used measures. Specifically, the

inclusion of studies using indices to probe attributions pertaining to a general spectrum of events, instead of probing trauma-specific attributions, may be the reason of observed variations across these studies.

Second, while some studies controlled for neurocognitive functioning (e.g., executive functioning in Nazarov et al., 2014, intelligence in Nietlisbach et al., 2010) and psychiatric comorbidity (e.g., secondary depressive disorder in Mazza et al., 2012), potential confounding effects of such or other unmeasured factors could not be excluded. Future studies should take such factors into account.

Third, while the present study included data concerning all social cognitive domains, the separate meta-analyses of the domains included a relatively small number of studies. The meta-analysis could not be conducted for social perception and the results for the other domains may have been underpowered, implying that significant effects may have been undetected. Hence, there is a need for studies comparing PTSD groups with non-clinical controls on social cognitive indices in order to further elucidate functioning across social cognitive domains in traumatized individuals. The incorporation of more studies would make it possible to further probe and detect potential effects of partitioned social cognitive domains, which would lead to an increased understanding with regard to the social cognitive profile in traumatized individuals. An increased understanding is of clinical importance, given that it could provide insights as to which domains could be seen as targets to intervene on.

Fourth, the findings were based on cross-sectional between-group comparison studies. Future longitudinal research should determine whether social cognitive deficits are a risk factor for developing PTSD symptomatology following trauma or to what extent traumatic events and the presence of PTSD contribute to problems in social cognition.

4.3. Conclusion

Regardless of these limitations, this study indicates that PTSD is accompanied by social cognitive impairments. The findings demonstrated that underlying social cognitive domains were differentially affected, indicating impairments in mentalization and social perception specifically. No deficiencies were found for emotion recognition and attributional style, yet future research should determine the role of trauma aetiology. Social cognition is an important clinical factor in the aetiology and maintenance of PTSD. The current study underscores the importance of differentiating between underlying social cognitive domains in research and treatment of PTSD.

Role of funding sources

This work was supported by the Dutch Ministry of Defence.

CRediT authorship contribution statement

Petrus G.J. Janssen: Visualization, Formal analysis, Writing – original draft. **Leanne A.C. van Est:** Visualization, Writing – original draft. **Mirrian Hilbink:** Formal analysis, Writing – original draft. **Loes Gubbels:** Visualization, Writing – original draft. **Jos Egger:** Writing – original draft. **Antonius H.N. Cillessen:** Writing – original draft. **Elisa van Ee:** Writing – original draft, Conceptualization.

Declaration of Competing Interest

None.

Acknowledgments

None.

References

- Allred, K.M., Chambless, D.L., Porter, E., Brier, M.J., Schwartz, R.A., 2018. Attributions and perceptions of criticism: an examination of patients with anxiety and normal control participants. *J. Fam. Psychol.* 32 (7), 947–956. <https://doi.org/10.1037/fam0000460>.
- American Psychiatric Association, 2013. *Diagnostic and Statistical Manual Of Mental Disorders*, 5th ed. American Psychiatric Publishing, Arlington, VA.
- Bell, C.J., Colhoun, H.C., Frampton, C.M., Douglas, K.M., McIntosh, V.V., Carter, F.A., Loughlin, A., 2017. Earthquake brain: altered recognition and misclassification of facial expressions are related to trauma exposure but not posttraumatic stress disorder. *Front. Psychiatry* 8. <https://doi.org/10.3389/fpsy.2017.00278>, 278–278.
- Berman, Z., Assaf, Y., Tarrasch, R., Joel, D., 2018. Assault-related self-blame and its association with PTSD in sexually assaulted women: an MRI inquiry. *Soc. Cognit. Affect. Neurosci.* 13 (7), 775–784. <https://doi.org/10.1093/scan/nsy044>.
- Boden, M.T., Westermann, S., McRae, K., Kuo, J., Alvarez, J., Kulkarni, M.R., Gross, J.J., Bonn-Miller, M.O., 2013. Emotion regulation and posttraumatic stress disorder: A prospective investigation. *J. Soc. Clin. Psy.* 32 (3), 296–314. <https://doi.org/10.1521/jscp.2013.32.3.296>.
- Boesch, L.E., Koss, M.P., Figueredo, A.J., Coan, J.A., 2001. Experiential avoidance and post-traumatic stress disorder: a cognitive mediational model of rape recovery. *J. Aggress. Maltreat. Trauma* 4 (2), 211–245. https://doi.org/10.1300/J146v04n02_10.
- Boffa, J.W., Norr, A.M., Tock, J.L., Amir, N., Schmidt, N.B., 2018. Development of the interpretation bias index for PTSD. *Cognit. Ther. Res.* 42 (5), 720–734. <https://doi.org/10.1007/s10608-018-9915-8>.
- Bomyea, J., Johnson, A., Lang, A.J., 2017. Information processing in PTSD: Evidence for biased attentional, interpretation, and memory processes. *Psychopathol. Rev.* 4 (3), 218–243.
- Brewin, C., Andrews, B., Valentine, J., 2000. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *J. Consult. Clin. Psychol.* 68 (5), 748–766. <https://doi.org/10.1037/0022-006X.68.5.748>.
- Cohen, J., 2013. *Statistical Power Analysis for the Behavioral Sciences*. Academic Press.
- Dirkzwager, A.J., Bramsen, I., Van Der Ploeg, H.M., 2003. Social support, coping, life events, and posttraumatic stress symptoms among former peacekeepers: a prospective study. *Personal. Individ. Differ.* 34 (8), 1545–1559. [https://doi.org/10.1016/S0191-8869\(02\)00198-8](https://doi.org/10.1016/S0191-8869(02)00198-8).
- Ehlers, A., Clark, D.M., 2000. A cognitive model of posttraumatic stress disorder. *Behav. Res. Ther.* 38 (4), 319–345. [https://doi.org/10.1016/S0005-7967\(99\)00123-0](https://doi.org/10.1016/S0005-7967(99)00123-0).
- Ehring, T., Quack, D., 2010. Emotion regulation difficulties in trauma survivors: The role of trauma type and PTSD symptom severity. *Behavior Therapy* 41 (4), 587–598. <https://doi.org/10.1016/j.beth.2010.04.004>.
- Elwood, L.S., Williams, N.L., Olatunji, B.O., Lohr, J.M., 2007. Interpretation biases in victims and non-victims of interpersonal trauma and their relation to symptom development. *J. Anxiety Disord.* 21 (4), 554–567.
- Fertuck, E.A., Tsoi, F., Grinband, J., Ruglass, L., Melara, R., Hien, D.A., 2016. Facial trustworthiness perception bias elevated in individuals with PTSD compared to trauma exposed controls. *Psychiatry Res.* 237, 43–48. <https://doi.org/10.1016/j.psychres.2016.01.056>.
- Filipas, H.H., Ullman, S.E., 2006. Child sexual abuse, coping responses, self-blame, posttraumatic stress disorder, and adult sexual revictimization. *J. Interpers. Violence* 21 (5), 652–672. <https://doi.org/10.1177/0886260506286879>.
- Fonzo, G.A., Simmons, A.N., Thorp, S.R., Norman, S.B., Paulus, M.P., Stein, M.B., 2010. Exaggerated and disconnected insular-amygdalar BOLD response to threat-related emotional faces in women with intimate-partner violence PTSD. *Biol. Psychiatry* 68 (5), 433–441. <https://doi.org/10.1016/j.biopsych.2010.04.028>.
- Gebhardt, C., Alliger-Horn, C., Mitte, K., Glaesmer, H., 2017. All-or-nothing thinking: the processing of emotional expressions in traumatized post-deployment soldiers. *J. Anxiety Disord.* 47, 69–74. <https://doi.org/10.1016/j.janxdis.2016.12.004>.
- Gonzalo, D., Kleim, B., Donaldson, C., Moorey, S., Ehlers, A., 2012. How disorder-specific are depressive attributions? A comparison of individuals with depression, post-traumatic stress disorder and healthy controls. *Cognit. Ther. Res.* 36 (6), 731–739. <https://doi.org/10.1007/s10608-011-9429-0>.
- Gray, M.J., Pumphrey, J.E., Lombardo, T.W., 2003. The relationship between dispositional pessimistic attributional style versus trauma-specific attributions and PTSD symptoms. *J. Anxiety Disord.* 17 (3), 289–303. [https://doi.org/10.1016/S0887-6185\(02\)00205-0](https://doi.org/10.1016/S0887-6185(02)00205-0).
- Green, M.F., Penn, D.L., Bentall, R., Carpenter, W.T., Gaebel, W., Gur, R.C., Heinsen, R., 2008. Social cognition in schizophrenia: an NIMH workshop on definitions, assessment, and research opportunities. *Schizophr. Bull.* 34 (6), 1211–1220. <https://doi.org/10.1093/schbul/sbm145>.
- Higgins, J.P., Thompson, S.G., Deeks, J.J., Altman, D.G., 2003. Measuring inconsistency in meta-analyses. *BMJ* 327 (7414), 557–560. <https://doi.org/10.1136/bmj.327.7414.557>.
- Hofman, N.L., Hahn, A.M., Tirabassi, C.K., Gaher, R.M., 2016. Social support, emotional intelligence, and posttraumatic stress disorder symptoms. *J. Individ. Differ.* 37 (1), 31–39. <https://doi.org/10.1027/1614-0001/a000185>.
- Janke, K., Driessen, M., Behnia, B., Wingenfeld, K., Roepke, S., 2018. Emotional intelligence in patients with posttraumatic stress disorder, borderline personality disorder and healthy controls. *Psychiatry Res.* 264, 290–296. <https://doi.org/10.1016/j.psychres.2018.03.078>.
- Jankowski, M.K., Schnurr, P.P., Adams, G.A., Green, B.L., Ford, J.D., Friedman, M.J., 2004. A mediational model of PTSD in World War II veterans exposed to mustard gas. *J. Trauma Stress* 17 (4), 303–310. <https://doi.org/10.1023/B:JOTS.0000038478.63664.5f>.
- Kimble, M., Batterink, L., Marks, E., Ross, C., Fleming, K., 2012. Negative expectancies in posttraumatic stress disorder: neurophysiological (N400) and behavioral evidence. *J. Psychiatr. Res.* 46 (7), 849–855.
- Lavoie, M.A., Battaglia, M., Achim, A.M., 2014. A meta-analysis and scoping review of social cognition performance in social phobia, posttraumatic stress disorder and other anxiety disorders. *J. Anxiety Disord.* 28 (2), 169–177. <https://doi.org/10.1016/j.janxdis.2013.09.005>.
- Masten, C.L., Guyer, A.E., Hodgdon, H.B., McClure, E.B., Charney, D.S., Ernst, M., Monk, C.S., 2008. Recognition of facial emotions among maltreated children with high rates of post-traumatic stress disorder. *Child Abuse Negl.* 32 (1), 139–153.
- Mazza, M., Giusti, L., Albanese, A., Mariano, M., Pino, M.C., Roncone, R., 2012. Social cognition disorders in military police officers affected by posttraumatic stress disorder after the attack of An-Nasiriyah in Iraq 2006. *Psychiatry Res.* 198 (2), 248–252. <https://doi.org/10.1016/j.psychres.2011.11.027>.
- Mazza, M., Tempesta, D., Pino, M.C., Nigri, A., Catalucci, A., Guadagni, V., Ferrara, M., 2015. Neural activity related to cognitive and emotional empathy in post-traumatic stress disorder. *Behav. Brain Res.* 282, 37–45. <https://doi.org/10.1016/j.bbr.2014.12.049>.
- McCormick, R.A., Taber, J.I., Kruegelbach, N., 1989. The relationship between attributional style and post-traumatic stress disorder in addicted patients. *J. Trauma Stress* 2 (4), 477–487. <https://doi.org/10.1002/jts.2490020410>.
- McCroory, E.J., Viding, E., 2015. The theory of latent vulnerability: reconceptualizing the link between childhood maltreatment and psychiatric disorder. *Dev. Psychopathol.* 27 (2), 493–505. <https://doi.org/10.1017/S0954579415000115>.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., Altman, D., Antes, G., Clark, J., 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann. Intern. Med.* 151 (4), 264–269. <https://doi.org/10.1371/journal.pmed.1000097>.
- Naim, R., Abend, R., Wald, I., Eldar, S., Levi, O., Fruchter, E., Bar-Haim, Y., 2015. Threat-related attention bias variability and posttraumatic stress. *Am. J. Psychiatry* 172 (12), 1242–1250.
- Najdowski, C.J., Ullman, S.E., 2009. PTSD symptoms and self-rated recovery among adult sexual assault survivors: the effects of traumatic life events and psychosocial variables. *Psychol. Women Q.* 33 (1), 43–53. <https://doi.org/10.1111/j.1471-6402.2008.01473.x>.
- Nazarov, A., Frewen, P., Oremus, C., Schellenberg, E.G., McKinnon, M.C., Lanius, R., 2015. Comprehension of affective prosody in women with post-traumatic stress disorder related to childhood abuse. *Acta Psychiatr. Scand.* 131 (5), 342–349. <https://doi.org/10.1111/acps.12364>.
- Nazarov, A., Frewen, P., Parlar, M., Oremus, C., MacQueen, G., McKinnon, M., Lanius, R., 2014. Theory of mind performance in women with posttraumatic stress disorder related to childhood abuse. *Acta Psychiatr. Scand.* 129 (3), 193–201. <https://doi.org/10.1111/acps.12142>.
- Nietlisbach, G., Maercker, A., Rösler, W., Haker, H., 2010. Are empathic abilities impaired in posttraumatic stress disorder? *Psychol. Rep.* 106 (3), 832–844. <https://doi.org/10.2466/pr0.106.3.832-844>.
- Ozer, E.J., Best, S.R., Lipsey, T.L., Weiss, D.S., 2003. Predictors of posttraumatic stress disorder and symptoms in adults: a meta-analysis. *Psychol. Bull.* 129 (1), 52–73. <https://doi.org/10.1037/0033-2909.129.1.52>.
- Palgi, S., Klein, E., Shamay-Tsoory, S.G., 2016. Oxytocin improves compassion toward women among patients with PTSD. *Psychoneuroendocrinology* 64, 143–149. <https://doi.org/10.1016/j.psyneuen.2015.11.008>.
- Passardi, S., Peyk, P., Rufer, M., Plichta, M.M., Mueller-Pfeiffer, C., Wingenbach, T.S., Pfaltz, M.C., 2018. Impaired recognition of positive emotions in individuals with posttraumatic stress disorder, cumulative traumatic exposure, and dissociation. *Psychother. Psychosom.* 87 (2), 118–120. <https://doi.org/10.1159/000486342>.
- Pitman, R.K., Rasmusson, A.M., Koenen, K.C., Shin, L.M., Orr, S.P., Gilbertson, M.W., Liberzon, I., 2012. Biological studies of post-traumatic stress disorder. *Nat. Rev. Neurosci.* 13 (11), 769–787. <https://doi.org/10.1038/nrn3339>.
- Poljac, E., Montagne, B., De Haan, E.H., 2011. Reduced recognition of fear and sadness in post-traumatic stress disorder. *Cortex* 47 (8), 974–980. <https://doi.org/10.1016/j.cortex.2010.10.002>.
- Roelofs, R.L., Wingbermühle, E., Egger, J.I., Kessels, R.P., 2017. Social cognitive interventions in neuropsychiatric patients: A meta-analysis. *Brain Impairment* 18 (1), 138–173. <https://doi.org/10.1017/BrImp.2016.31>.
- Schmidt, J.Z., Zachariae, R., 2009. PTSD and impaired eye expression recognition: a preliminary study. *J. Loss Trauma* 14 (1), 46–56. <https://doi.org/10.1080/15325020802537096>.
- Schnurr, P.P., Lunney, C.A., Sengupta, A., 2004. Risk factors for the development versus maintenance of posttraumatic stress disorder. *J. Traum. Stress* 17 (2), 85–95. <https://doi.org/10.1023/B:JOTS.0000022614.21794.f4>. Official Publication of The International Society for Traumatic Stress Studies.
- Sharp, C., Fonagy, P., Allen, J.G., 2012. Posttraumatic stress disorder: a social-cognitive perspective. *Clin. Psychol. Sci. Pract.* 19 (3), 229–240. <https://doi.org/10.1111/cpsp.12002>.
- Stevens, J.S., Jovanovic, T., 2019. Role of social cognition in post-traumatic stress disorder: a review and meta-analysis. *Genes, Brain and Behav.* 18 (1), e12518. <https://doi.org/10.1111/gbb.12518>.
- Shepherd, L., Wild, J., 2014. Emotion regulation, physiological arousal and PTSD symptoms in trauma-exposed individuals. *J. Beh. Ther. Exp. Psy.* 45 (3), 360–367. <https://doi.org/10.1016/j.jbtep.2014.03.002>.
- Simmons, A.N., Matthews, S.C., Strigo, I.A., Baker, D.G., Donovan, H.K., Motezadi, A., Paulus, M.P., 2011. Altered amygdala activation during face processing in Iraqi and Afghanistani war veterans. *Biol. Mood Anxiety Disord.* 1 (1) <https://doi.org/10.1186/2045-5380-1-6>, 6–6.

- Solomon, Z., Mikulincer, M., Waysman, M., Marlowe, D.H., 1991. Delayed and immediate onset posttraumatic stress disorder. *Soc. Psychiatry Psychiatr. Epidemiol.* 26 (1), 1–7. >[https://doi.org/10.1002/1520-6629\(199107\)19:3<231::AID-JCOP2290190304>3.0.CO;2-C](https://doi.org/10.1002/1520-6629(199107)19:3<231::AID-JCOP2290190304>3.0.CO;2-C).
- Steuwe, C., Daniels, J.K., Frewen, P.A., Densmore, M., Pannasch, S., Beblo, T., Lanius, R. A., 2014. Effect of direct eye contact in PTSD related to interpersonal trauma: An fMRI study of activation of an innate alarm system. *Social Cognit. Neurosci.* 9 (1), 88–97. <https://doi.org/10.1093/scan/nss105>.
- Tabachnick, B.G., Fidell, L.S., Ullman, J.B., 2007. *Using Multivariate Statistics*, 5. Pearson, Boston, MA, pp. 481–498.
- Van den Heuvel, O.A., Veltman, D.J., Groenewegen, H.J., Witter, M.P., Merkelbach, J., Cath, C.C., Van Balkom, A.J.L.M., Van Oppen, P., Van Dyck, R., Van Dyck, R., 2005. Disorder-specific neuroanatomical correlates of attentional bias in obsessive-compulsive disorder, panic disorder, and hypochondriasis. *Arch. Gen. Psy.* 62 (8), 922–933. <https://doi.org/10.1001/archpsyc.62.8.922>.
- Viechtbauer, W., Cheung, M.W.L., 2010. Outlier and influence diagnostics for meta-analysis. *Res. Synth. Methods* 1 (2), 112–125. <https://doi.org/10.1002/jrsm.11>.
- Wenninger, K., Ehlers, A., 1998. Dysfunctional cognitions and adult psychological functioning in child sexual abuse survivors. *J. Trauma Stress* 11, 281–300. <https://doi.org/10.1023/A:1024451103931>.
- Zoladz, P.R., Diamond, D.M., 2013. Current status on behavioral and biological markers of PTSD: a search for clarity in a conflicting literature. *Neurosci. Biobehav. Rev.* 37 (5), 860–895. <https://doi.org/10.1016/j.neubiorev.2013.03.024>.