

## A Social–Cognitive–Neuroscience Approach to PTSD: Clinical and Research Perspectives

RUTH LANIUS, PAUL FREWEN, ANTHONY NAZAROV,  
AND MARGARET C. MCKINNON

*Embodiment implies that the same neural systems are engaged for self- and other-understanding through a simulation mechanism, while mentalizing refers to the use of high-level conceptual information to make inferences about the mental states of self and others. These mechanisms work together to provide a coherent representation of the self and by extension, of others.*

—Istvan Molnar-Szakacs and Lucina Q. Uddin (2013)

A social–cognitive and affective theoretical model pertaining to individuals who suffer from posttraumatic stress disorder (PTSD) as a result of repeated traumatization has recently been proposed (Lanius, Bluhm, & Frewen, 2011). This model focuses on disturbances in the affective and social domain of PTSD, including emotional awareness, affect dysregulation, social cognition, and self-referential processing. In this chapter, we will review disturbances in self-referential processing and social cognition in PTSD related to early-life trauma. The default mode brain network consisting of cortical midline brain regions has been suggested to underlie both of these two important interrelated processes. First, the neural underpinnings of self-referential processing and how they may relate the integrity of the default

mode network (DMN) will be discussed. Second, deficits in social cognition, with a particular focus on theory of mind in PTSD and the neural circuitry underlying direct versus avert eye contact will be described. Implications for assessment and treatment will be addressed.

### SELF-REFERENTIAL PROCESSING AND THE DMN IN PTSD

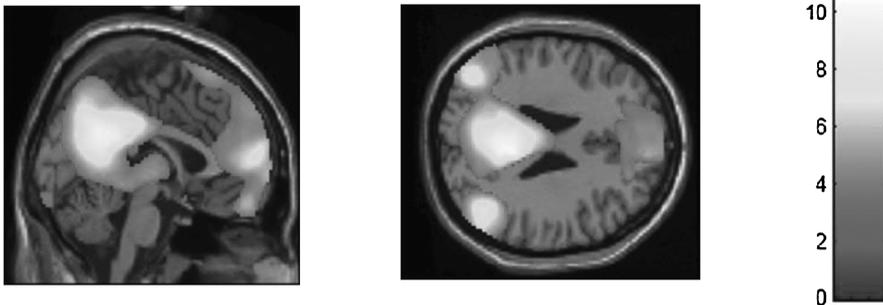
PTSD is often associated with profound disturbances in self-referential processing (Bryant & Guthrie, 2007; Foa, Ehlers, Clark, Tolin, & Orsillo, 1999); it is also reviewed in Liberzon and Martis (2006) as exemplified by symptoms of emotional numbing, alexithymia (Frewen et al., 2008, 2012), and dissociation, including depersonalization, derealization, and identity disturbance (Herman, 1997; Lanius et al., 2010; van der Kolk, Roth, Pelcovitz, Sunday, & Spinazzola, 2005). Moreover, symptoms of shame often lead the individual to feel bad, despicable, and/or identified with the perpetrator (Andrews, Brewin, Rose, & Kirk, 2000; Cloitre, Cohen, & Koenen, 2006; Herman, 1997). Individuals suffering from PTSD therefore often experience a change in their identity and feel like they, as a person, and their lives have permanently changed for the worse (Foa et al., 1999; see Brewin & Holmes, 2003; Dalgleish, 2004 for reviews). These symptoms have recently been incorporated into the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* under the category of negative alterations in cognitions and mood associated with traumatic event(s) (American Psychiatric Association, 2013; Friedman, Resick, Bryant, & Brewin, 2011).

The DMN is a brain network that has been shown to be associated with self-referential processing (Buckner, Andrews-Hanna, & Schacter, 2008; Raichle et al., 2001; Raichle, 2010) and is thought to help prepare the organism for future demands of the environment. The DMN also overlaps significantly with brain regions that have been associated with autobiographical memory and higher-order social cognition, including theory of mind (Spreng & Grady, 2010), suggesting that this network may be involved in the PTSD symptoms not only related to the recall of traumatic events but also to social cognition (see below). Johnson et al. (2002) demonstrated that self-referential processing is associated with the activation of cortical midline structures and therefore overlaps with key areas of the DMN in healthy individuals. Given the deficits in self-referential processing in PTSD, as described above, Bluhm and colleagues have used the same experimental paradigm as Johnson et al. (2002) to demonstrate altered neural activation patterns in brain regions implicated in self-referential processing in patients with PTSD (Bluhm et al., 2012). This paradigm involved assessing the self-relevance of personal characteristics (e.g., I get angry easily) versus the accuracy of general facts (e.g., Paris is the capital of France); both reaction times and neural activation patterns were examined. Healthy individuals exhibited faster responses to the self-relevance of personal characteristics than to the accuracy of general facts. In contrast, PTSD patients did not differ between these conditions. In terms of brain activation patterns, healthy individuals exhibited greater dorsal and ventral medial prefrontal cortex (VMPFC) and posterior cingulate activation while assessing the self-relevance of personal characteristics in comparison with the accuracy of

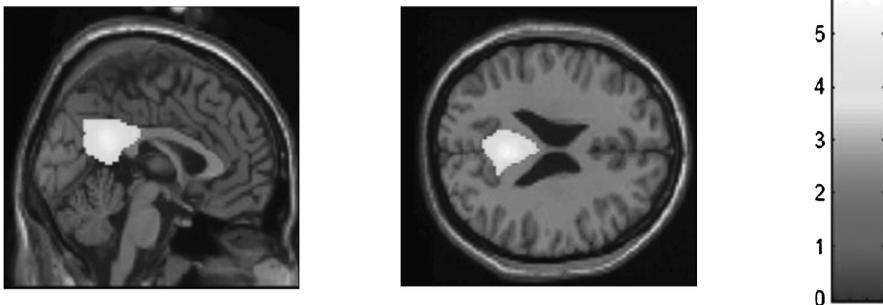
general facts. In PTSD subjects, less activation of the medial prefrontal cortex (PFC) was observed for the contrast of self-relevance of personal characteristics relative to general facts as compared to controls.

Given that individuals with PTSD have shown deficits in self-referential processing as well as altered brain activation in brain regions associated with the default network, including the medial PFC, anterior cingulate, posterior cingulate cortex, and parietal cortex (Bremner et al., 1999; Bryant et al., 2008; Geuze et al., 2007; Lanius et al., 2001; Liberzon et al., 1999; Shin et al., 1999; Williams et al., 2006), an examination of the integrity of the DMN in PTSD was warranted. Bluhm et al. (2009) first examined the DMN in PTSD patients related to childhood abuse and showed significantly reduced resting state connectivity within regions of the DMN. Specifically, the PTSD group exhibited decreased connectivity between the posterior cingulate seed region and the medial PFC, right superior frontal gyrus, and left thalamus (see Figure 4.1). Furthermore, the connectivity of the medial prefrontal seed region was restricted to neighboring regions within the medial PFC and did not extend to other areas of the DMN. Similar results have recently been reported by Sripada et al. (2012).

**Controls: Positive Correlation 0, -56, 20**



**PTSD: Positive Correlation 0, -56, 20**



**FIGURE 4.1** Default mode network connectivity in control (top panel) and PTSD subjects (bottom panel).

Areas of correlation with posterior cingulate/precuneus in healthy comparison subjects ( $n = 15$ ) and in patients with PTSD ( $n = 17$ ), thresholded at  $p < .05$ , corrected using False Discovery Rate Correction. PTSD, posttraumatic stress disorder.

Figure published with permission in Bluhm et al. (2009).

It has recently been suggested that early-life adversity can affect the developmental trajectory of the DMN. In fact, reduced anterior–posterior DMN connectivity as exhibited in patients suffering from PTSD related to childhood abuse appears to bear resemblance to the DMN connectivity observed in children aged 7 to 9. This suggests that early-life adversity may influence the maturation process of white matter tracts such as the corpus callosum, which connect the anterior–posterior brain regions of the DMN as a result of the toxic effects of stress hormones on the myelination process (Daniels, Frewen, McKinnon, & Lanius, 2011). It is interesting to note that decreased corpus callosum volumes have been reported in children with a history of childhood trauma as well as patients with PTSD related to early-life adversity (De Bellis et al., 1999; Kitayama et al., 2007). Further research will need to prospectively examine the integrity of the DMN in both traumatized and nontraumatized children and adolescents.

### THEORY OF MIND IN PTSD

The study of social cognition, including theory of mind (the ability to be aware of and understand others' behavior, intentions, and emotions; Premack, 1978), is particularly relevant to PTSD since patients suffering from this illness often exhibit profound interpersonal dysfunction, including disrupted functioning of the family unit, problems with intimacy and related difficulties forming and maintaining romantic relationships, in addition to an increased risk of interpersonal violence. The latter is likely partially related to the negative sense of self often experienced by these individuals (Frewen et al., in press), which leads them to feel deserving of being in abusive and destructive relationships. Moreover, alterations in social cognition such as theory of mind may underlie these some of these impairments in social functioning.

The majority of social–cognitive studies in PTSD to date have focused on empathic responding, emotion recognition, and theory of mind (Nietlisbach, Maercker, Rossler, & Haker, 2010). Theory of mind abilities are thought to be crucial to empathic responding since they require the capacity to recognize emotions that are being experienced by others. Nietlisbach and colleagues (2010) reported that individuals with a history of PTSD, as compared to controls, reported significantly higher levels of personal distress as assessed by the Interpersonal Reactivity Index (Bernstein & Fink, 1998; Lanius, Frewen, Vermetten, & Yehuda, 2010), a well-validated self-report measure of empathic responding. Several studies in PTSD have also documented deficits in recognizing facial emotion (e.g., happiness, sadness, anger [Knezevic & Jovancevic, 2004; Shin et al., 2005]; but see Orsillo, Batten, Plumb, Luterek, & Roessner, 2004; Wagner, Roemer, Orsillo, & Litz, 2003) for conflicting findings in facial expressivity, which may be intimately related to altered empathic responding and theory-of-mind processes in this disorder. Investigations examining theory-of-mind performance in individuals with PTSD have also been recently emerging. Most of these studies have utilized the Reading the Mind in the Eyes Task–Revised (RMET), during which subjects are presented with cropped photographs of faces that only display the eye region. Participants are then instructed

to choose an adjective that best describes what the person in the photograph may be thinking or feeling. Both Mazza et al., 2012 and Nietlishbach et al., 2010 found less accurate judgment of complex mental states using the RMET in individuals with PTSD. It should be noted however that, in the Nietlishbach et al. study, individuals with PTSD differed from controls only after statistically controlling for heterogeneity in time since trauma exposure. Further, in response to the Faux Pas Test, which involves the interpretation of social interactions including white lies, figures of speech, and irony, Nietlishbach et al. (2010) failed to find differences between individuals with PTSD in comparison with controls. Thus, such discrepancies in findings may be attributable to task differences, as well as variations in trauma exposure.

Our group has recently examined theory-of-mind deficits in women with PTSD related to childhood abuse using the RMET (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) and the Interpersonal Perception Task-15 (IPT-15; Costanzo & Archer, 1989; Nazarov et al., 2013). In the IPT-15 task, participants are shown brief video clips involving social interactions categorized into five domains, including kinship, status, competition, deception, and intimacy. Following each video clip, subjects are presented with a multiple-choice question about the nature of the interaction in each domain. The subject has to pay close attention to nonverbal cues in order to correctly answer the question; no explicit information pertaining to the question is provided during the videos. For example, one video focusing on the domain of kinship includes a conversation between a child and two adults. Based on both verbal and nonverbal behavior of the three persons, the subject has to determine which of the two adults is the child's parent.

Patients with PTSD related to childhood trauma exhibited theory-of-mind disturbances on both the IPT-15 and the RMET. Compared to healthy controls, individuals with PTSD related to interpersonal trauma exhibited difficulties interpreting scenes that portrayed kinship interactions. No disturbances in the other domains were observed. These results suggest that theory-of-mind disturbances in PTSD related to interpersonal trauma may specifically affect individuals' ability to interpret family situations. These findings may shed light on why individuals with PTSD often report problems with interpersonal violence (Stevens et al., 2013), marital functioning (Bagley & Ramsay, 1986), and maintaining stable adult relationships (Alexander et al., 1998). Moreover, theory-of-mind disturbances have been suggested to play a key role in difficulties parenting and thereby facilitating the intergenerational transmission trauma, that is, the development of psychopathology as a result of emotional regulatory disturbances in the parent(s). In this regard, it has been shown that therapies focusing on increasing theory-of-mind capacity, including mentalization-based treatments (Allen & Fonagy, 2006) have been shown to be effective in individuals who have suffered from disrupted early attachments and interpersonal trauma during childhood abuse as well as in mitigating the intergenerational transmission of trauma (reviewed in Lanius et al., 2011).

With regard to the RMET, members of the PTSD group did not differ in its ability to accurately label complex mental states as compared to healthy controls. However, individuals with PTSD exhibited significantly longer response latencies to photographs showing emotionally salient mental states but not neutral mental

states. Specifically, *slower* response times were only observed during the labeling of both positive and negative mental states, but not in response to neutral mental states. In contrast, healthy individuals exhibited *faster* response times to both emotionally salient (positive and negative) mental states in comparison to neutral states. These findings are consistent with research in healthy individuals that has demonstrated increased neural processing speed in response to the presence of an emotional component within facial expressions (Holmes, Bradley, Kragh Nielsen, & Mogg, 2009). In addition, it has been suggested that emotional processing of facial stimuli relies on top-down processes that depend on the accessibility of attentional resources (Pessoa, McKenna, Gutierrez, & Ungerleider, 2002). Several explanations of the slowed reaction times in PTSD must therefore be entertained. First, it is possible that individuals with PTSD exhibited slowed reaction times as a result of slowed neural processing of emotionally salient mental states. However, it is also feasible that individuals with PTSD became triggered or overwhelmed by the emotional states depicted in the RMET, thereby requiring additional attentional resources to deal with the increased cognitive load associated with processing overwhelming emotional stimuli. The latter could lead to a decreased capacity for higher-order social cognition, which may be associated with slower reaction times. Further research examining the role of attention in perspective taking, especially during emotionally salient mental states, are therefore needed. In this regard, it will be important to carefully code if and what specific emotional mental states on the RMET may be triggering or overwhelming for specific individuals with PTSD.

It is interesting to note that dissociative symptoms were associated with theory-of-mind performance on the RMET and the IPT-15 in our sample. In terms of the RMET, the presence of dissociative symptoms, including disengagement, memory disturbance, and identity dissociation were negatively associated with the accurate identification of positive and neutral mental states. Dissociative symptoms were also associated with altered perception of kinship interactions on the IPT-15. Taken together, these findings suggest that dissociation may lead to emotion overmodulation regulatory processes that distance the individual from emotional experience, thus leading to altered theory-of-mind performance. Future studies will need to take a transdiagnostic approach in populations with chronic childhood trauma in order to examine what specific symptoms (e.g., dissociation, dysphoria, hyperarousal symptoms) are particularly associated with altered theory-of-mind performance. Such investigations could then lead to treatment interventions that precisely target symptoms that are most associated with disturbed theory-of-mind performance in order to maximize treatment of altered social cognition in chronically traumatized populations. The latter would hopefully not only lead to improved social functioning in these patients but also alleviate the intergenerational transmission of trauma.

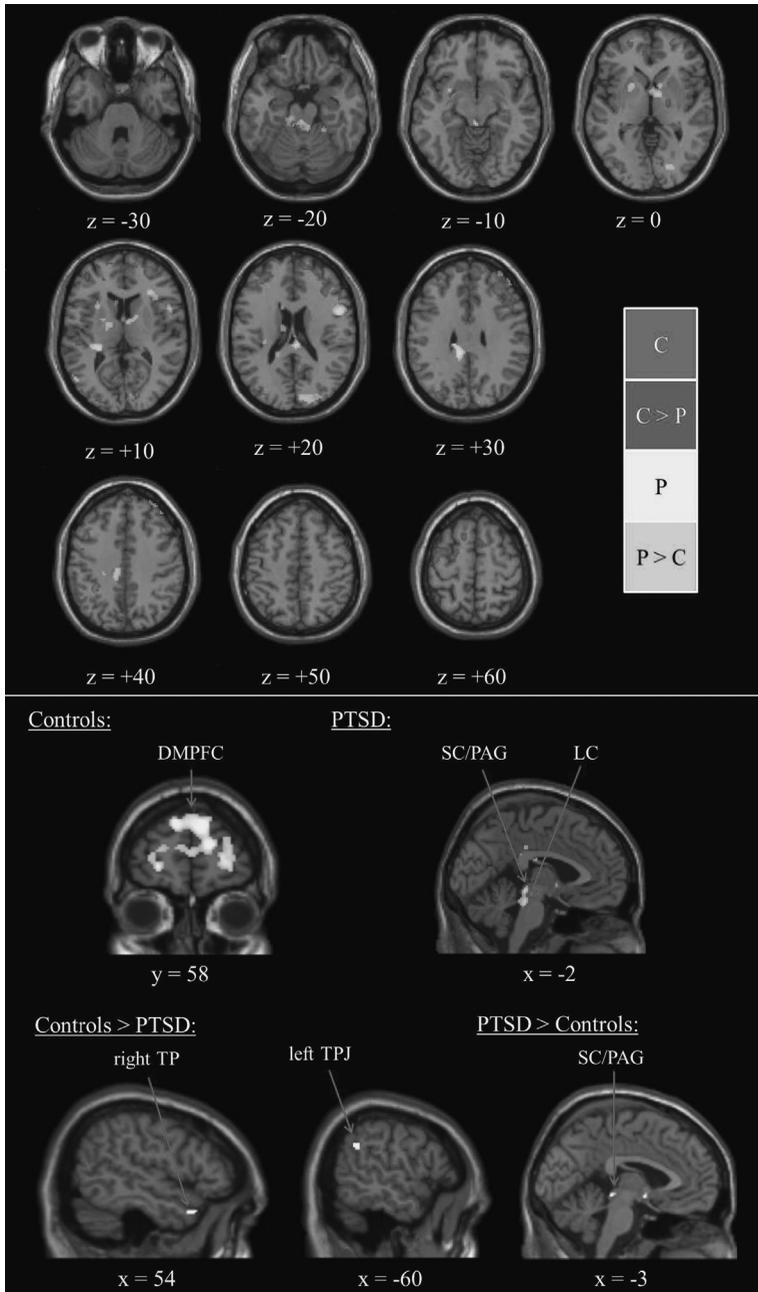
In addition to the study of theory-of-mind performance in PTSD related to childhood abuse, our group has also begun to examine social-cognitive processes neurobiologically. In the first set of experiments, individuals with PTSD were exposed to standardized social (rejection-shame) emotional imagery (e.g., imagining yourself in a situation where you are rejected by your friends or having a negative job evaluation)

or positive social situation (e.g., having a positive work performance evaluation) while having a functional MRI (fMRI) brain scan. In patients with PTSD related to prolonged childhood abuse, altered brain responses in key brain regions involved in higher-order social cognition (mentalizing and theory of mind), including the dorsomedial PFC, temporoparietal junction, temporal poles (TPs), and amygdala, were observed. These early findings suggest that the behavioral findings of altered theory-of-mind performance described above may be associated with altered neural activation of social–cognitive networks. Future research will need to examine the direct relationship between behavioral performance on social–cognitive tasks and how this may relate to altered neural activation patterns in related brain networks.

### **THEORY OF MIND AND DIRECT EYE CONTACT**

Mutual eye-to-eye contact is of fundamental importance in social interactions since it allows the individual to adopt the perspective of others and understand their intentions, emotions, and behaviors (Baron-Cohen, 1995; Tomasello & Carpenter, 2007). Given the deficits in theory-of-mind performance in patients with PTSD related to childhood abuse, the clinical observation that individuals with this disorder often have profound difficulties making direct eye contact, and the abnormalities observed in key brain regions underlying social cognition, a study examining the neural correlates of direct eye-to-eye contact using a virtual reality paradigm in individuals with PTSD related to childhood abuse was carried out (Steuwe et al., 2014). This paradigm involved comparing the effects of a direct versus averted gaze of male virtual characters in three emotional states (neutral, happy, angry) in the fMRI scanner.

Our findings suggest that in healthy controls direct versus averted gaze leads to activation of higher cortical structures, which facilitates evaluative “top-down” processes involved in social interactions. In contrast, in individuals with PTSD, direct versus averted gaze, independent of the emotional state of the virtual character, fails to initiate brain regions involved in higher-order social cognition but rather leads to activation of a subcortical structures including the superior colliculus (SC) and underlying circuits of the periaqueductal gray (PAG). These regions have been suggested to form an innate alarm system that facilitates defensive behaviors and decreased social affiliative interaction (see Figure 4.2). Activation of such lower brain structures in the absence of higher social cortical functioning may therefore decrease the individual’s ability to engage in theory-of-mind processes, thereby reducing the ability for optimum social functioning. Future studies will need to examine the effects of direct versus averted gaze in “live” characters versus virtual characters. It will also be important to study the relationship between autonomic response and brain activation patterns during direct versus avert eye contact. Finally, the effects of shame on direct eye contact and the ability of psychotherapy to potentially reverse the altered brain activation during direct gaze in individuals with PTSD will need to be a priority.



**FIGURE 4.2** Brain areas showing increased BOLD response during direct vs. averted gaze (vs. implicit baseline) for controls (C;  $n = 16$ ;  $p < .005$ ;  $k > 30$ ) and individuals with PTSD (P;  $n = 16$ ;  $p < .005$ ;  $k > 30$ ) as well as for the between-group comparisons controls > PTSD (C > P;  $p < .005$ ;  $k > 10$ ) and PTSD > controls (P > C;  $p < .005$ ;  $k > 10$ ). Upper three rows display all brain activation observed in transverse slices from  $z = -30$  to  $z = +60$ . Bottom two rows display regions of interest, showing increased activation during direct gaze as compared to averted gaze (vs. implicit baseline) within the controls and PTSD group as well as between groups (bottom row).

DMPFC, dorsomedial prefrontal cortex; LC, locus coeruleus; PAG, periaqueductal gray; PTSD, posttraumatic stress disorder; SC, superior colliculus; TP, temporal pole; TPJ, temporoparietal junction.

Figure published with permission in Steuwe et al. (2014).

## CONCLUSIONS

In this chapter, we have reviewed alterations in self-referential processing and social cognition, including theory of mind and direct eye gaze in PTSD related to early-life trauma, and the neural underpinnings of both of these processes have been discussed. Even though these findings remain preliminary, they raise important future research and clinical questions: (a) To what extent can effective treatment for PTSD related to early-life trauma reverse the altered neural circuitry involved in self-referential processing and social cognition, and what clinical impact would be associated with such neuroplastic changes? (b) Do alterations in the neuronal circuitry underlying social cognition in PTSD interfere with the ability to engage socially and therefore decrease the ability to utilize social support posttrauma? This is an important question since social support has been identified to be one of the most important posttrauma predictors of recovery (Ozer, Best, Lipsey, & Weiss, 2003). (c) What are the effects of altered social cognition and self-referential processing on the intergenerational transmission of trauma (see Fonagy), and what interventions are most effective to mitigate such effects? (d) Do PTSD patients with deficits in social cognition have difficulties engaging in treatment, and how can such problems best be addressed? We hope that this research will lead to an ongoing dialogue between clinicians and researchers in order to further advance our understanding of the complex adaptations to psychological trauma.

## REFERENCES

- Alexander, P. C., Anderson, C. L., Brand, B., Schaeffer, C. M., Grelling, B. Z., & Kretz, L. (1998). Adult attachment and long-term effects in survivors of incest. *Child Abuse & Neglect*, 22(1), 45–61.
- Allen, J. G., & Fonagy, P. (Eds.). (2006). *Handbook of mentalization-based treatment*. Chichester, UK: John Wiley & Sons.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.
- Andrews, B., Brewin, C. R., Rose, S., & Kirk, M. (2000). Predicting PTSD symptoms in victims of violent crime: The role of shame, anger, and childhood abuse. *Journal of Abnormal Psychology*, 109(1), 69–73.
- Bagley, C., & Ramsay, R. (1986). Sexual abuse in childhood. *Journal of Social Work & Human Sexuality*, 4, 33–47.
- Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press.
- Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The “Reading the Mind in the Eyes” Test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 42(2), 241–251.
- Bernstein, D. P., & Fink, L. (1998). *Childhood trauma questionnaire: A retrospective self-report*. San Antonio, TX: Harcourt Brace & Company.
- Bluhm, R. L., Frewen, P. A., Coupland, N. C., Densmore, M., Schore, A. N., & Lanius, R. A. (2012). Neural correlates of self-reflection in post-traumatic stress disorder. *Acta Psychiatrica Scandinavica*, 125(3), 238–246.

- Bluhm, R. L., Williamson, P. C., Osuch, E. A., Frewen, P. A., Stevens, T. K., Boksman, K., ... Lanius, R. A. (2009). Alterations in default network connectivity in posttraumatic stress disorder related to early-life trauma. *Journal of Psychiatry & Neuroscience: JPN*, *34*(3), 187–194.
- Bremner, J. D., Staib, L. H., Kaloupek, D., Southwick, S. M., Soufer, R., & Charney, D. S. (1999). Neural correlates of exposure to traumatic pictures and sound in Vietnam combat veterans with and without posttraumatic stress disorder: A positron emission tomography study. *Biological Psychiatry*, *45*(7), 806–816.
- Brewin, C. R., & Holmes, E. A. (2003). Psychological theories of posttraumatic stress disorder. *Clinical Psychology Review*, *23*(3), 339–376.
- Bryant, R. A., Felmingham, K., Kemp, A., Das, P., Hughes, G., Peduto, A., & Williams, L. (2008). Amygdala and ventral anterior cingulate activation predicts treatment response to cognitive behaviour therapy for post-traumatic stress disorder. *Psychological Medicine*, *38*(4), 555–561.
- Bryant, R. A., & Guthrie, R. M. (2007). Maladaptive self-appraisals before trauma exposure predict posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology*, *75*(5), 812–815.
- Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: Anatomy, function, and relevance to disease. *Annals of the New York Academy of Sciences*, *1124*, 1–38.
- Cloitre, M., Cohen, L. R., & Koenen, K. C. (2006). *Treating survivors of childhood abuse: Psychotherapy for interrupted life*. New York, NY: Guilford Press.
- Costanzo, M., & Archer, D. (1989). Interpreting the expressive behavior of others: The interpersonal perception task. *Journal of Nonverbal Behavior*, *13*, 225.
- Dalgleish, T. (2004). Cognitive approaches to posttraumatic stress disorder: The evolution of multirepresentational theorizing. *Psychological Bulletin*, *130*(2), 228–260.
- Daniels, J. K., Frewen, P., McKinnon, M. C., & Lanius, R. A. (2011). Default mode alterations in posttraumatic stress disorder related to early-life trauma: A developmental perspective. *Journal of Psychiatry & Neuroscience: JPN*, *36*(1), 56–59.
- De Bellis, M. D., Keshavan, M. S., Clark, D. B., Casey, B. J., Giedd, J. N., Boring, A. M., ... Ryan, N. D. (1999). A.E. Bennett Research Award. Developmental traumatology. Part II: Brain development. *Biological Psychiatry*, *45*(10), 1271–1284.
- Foa, E. B., Ehlers, A., Clark, D. M., Tolin, D. F., & Orsillo, S. M. (1999). The posttraumatic cognitions inventory (PTCI): Development and validation. *Psychological Assessment*, *11*, 303–314.
- Frewen, P. A., Dozois, D. J., Neufeld, R. W., Lane, R. D., Densmore, M., Stevens, T. K., & Lanius, R. A. (2012). Emotional numbing in posttraumatic stress disorder: A functional magnetic resonance imaging study. *The Journal of Clinical Psychiatry*, *73*(4), 431–436.
- Frewen, P. A., Dozois, D. J. A., Neufeld, R. W. J., Densmore, M., Stevens, T., & Lanius, R. A. (in press). Self-referential processing in women with PTSD related to childhood abuse: Affective and neural response. *Psychological Trauma: Theory, Research, Practice, and Policy*.
- Frewen, P. A., Lanius, R. A., Dozois, D. J., Neufeld, R. W., Pain, C., Hopper, J. W., ... Stevens, T. K. (2008). Clinical and neural correlates of alexithymia in posttraumatic stress disorder. *Journal of Abnormal Psychology*, *117*(1), 171–181.
- Friedman, M. J., Resick, P. A., Bryant, R. A., & Brewin, C. R. (2011). Considering PTSD for DSM-5. *Depression and Anxiety*, *28*(9), 750–769.
- Geuze, E., Westenberg, H. G., Jochims, A., de Kloet, C. S., Bohus, M., Vermetten, E., & Schmah, C. (2007). Altered pain processing in veterans with posttraumatic stress disorder. *Archives of General Psychiatry*, *64*(1), 76–85.
- Herman, J. (1997). *Trauma and recovery: The Aftermath of violence - from domestic abuse to political terror*. New York, NY: Basic Books.

- Holmes, A., Bradley, B. P., Kragh Nielsen, M., & Mogg, K. (2009). Attentional selectivity for emotional faces: Evidence from human electrophysiology. *Psychophysiology*, *46*(1), 62–68.
- Johnson, S. C., Baxter, L. C., Wilder, L. S., Pipe, J. G., Heiserman, J. E., & Prigatano, G. P. (2002). Neural correlates of self-reflection. *Brain: A Journal of Neurology*, *125*(Pt 8), 1808–1814.
- Kitayama, N., Brummer, M., Hertz, L., Quinn, S., Kim, Y., & Bremner, J. D. (2007). Morphologic alterations in the corpus callosum in abuse-related posttraumatic stress disorder: A preliminary study. *The Journal of Nervous and Mental Disease*, *195*(12), 1027–1029.
- Knezevic, M., & Jovancevic, M. (2004). The IFEEL pictures: Psychological trauma and perception, and interpretation of child's emotions. *Nordic Journal of Psychiatry*, *58*(2), 139–145.
- Lanius, R. A., Bluhm, R. L., & Frewen, P. A. (2011). How understanding the neurobiology of complex post-traumatic stress disorder can inform clinical practice: A social cognitive and affective neuroscience approach. *Acta Psychiatrica Scandinavica*, *124*(5), 331–348.
- Lanius, R. A., Frewen, P. A., Vermetten, E., & Yehuda, R. (2010). Fear conditioning and early life vulnerabilities: Two distinct pathways of emotional dysregulation and brain dysfunction in PTSD. *European Journal of Psychotraumatology*, *1*, 5467–5477.
- Lanius, R. A., Vermetten, E., Loewenstein, R. J., Brand, B., Schmahl, C., Bremner, J. D., & Spiegel, D. (2010). Emotion modulation in PTSD: Clinical and neurobiological evidence for a dissociative subtype. *The American Journal of Psychiatry*, *167*(6), 640–647.
- Lanius, R. A., Williamson, P. C., Densmore, M., Boksman, K., Gupta, M. A., Neufeld, R. W., ... Menon, R. S. (2001). Neural correlates of traumatic memories in posttraumatic stress disorder: A functional MRI investigation. *The American Journal of Psychiatry*, *158*(11), 1920–1922.
- Liberzon, I., & Martis, B. (2006). Neuroimaging studies of emotional responses in PTSD. *Annals of the New York Academy of Sciences*, *1071*, 87–109.
- Liberzon, I., Taylor, S. F., Amdur, R., Jung, T. D., Chamberlain, K. R., Minoshima, S., ... Fig, L. M. (1999). Brain activation in PTSD in response to trauma-related stimuli. *Biological Psychiatry*, *45*(7), 817–826.
- 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 Research*, *198*(2), 248–252.
- Molnar-Szakacs, I., & Uddin, L. Q. (2013). Self-processing and the default mode network: Interactions with the mirror neuron system. *Frontiers in Human Neuroscience*, *7*, 571.
- Nazarov, A., Frewen, P., Parlar, M., Oremus, C., MacQueen, G., McKinnon, M., & Lanius, R. (2013). Theory of mind performance in women with posttraumatic stress disorder related to childhood abuse. *Acta Psychiatrica Scandinavica* (e-pub ahead of print).
- Nietlisbach, G., Maercker, A., Rössler, W., & Haker, H. (2010). Are empathic abilities impaired in posttraumatic stress disorder? *Psychological Reports*, *106*(3), 832–844.
- Orsillo, S. M., Batten, S. V., Plumb, J. C., Luterek, J. A., & Roessner, B. M. (2004). An experimental study of emotional responding in women with posttraumatic stress disorder related to interpersonal violence. *Journal of Traumatic Stress*, *17*(3), 241–248.
- 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. *Psychological Bulletin*, *129*(1), 52–73.
- Pessoa, L., McKenna, M., Gutierrez, E., & Ungerleider, L. G. (2002). Neural processing of emotional faces requires attention. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(17), 11458–11463.
- Premack, D. W. G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences*, *1*, 515–526.
- Raichle, M. E. (2010). The brain's dark energy. *Scientific American*, *302*(3), 44–49.

- Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences of the United States of America*, *98*(2), 676–682.
- Shin, L. M., McNally, R. J., Kosslyn, S. M., Thompson, W. L., Rauch, S. L., Alpert, N. M.,... Pitman, R. K. (1999). Regional cerebral blood flow during script-driven imagery in childhood sexual abuse-related PTSD: A PET investigation. *The American Journal of Psychiatry*, *156*(4), 575–584.
- Shin, L. M., Wright, C. I., Cannistraro, P. A., Wedig, M. M., McMullin, K., Martis, B.,... Rauch, S. L. (2005). A functional magnetic resonance imaging study of amygdala and medial prefrontal cortex responses to overtly presented fearful faces in posttraumatic stress disorder. *Archives of General Psychiatry*, *62*(3), 273–281.
- Spreng, R. N., & Grady, C. L. (2010). Patterns of brain activity supporting autobiographical memory, prospection, and theory-of-mind and their relationship to the default mode network. *Journal of Cognitive Neuroscience*, *22*(6), 1112–1123.
- Sripada, R. K., King, A. P., Welsh, R. C., Garfinkel, S. N., Wang, X., Sripada, C. S., & Liberzon, I. (2012). Neural dysregulation in posttraumatic stress disorder: Evidence for disrupted equilibrium between salience and default mode brain networks. *Psychosomatic Medicine*, *74*(9), 904–911.
- 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 Cognitive and Affective Neuroscience*, *9*(1), 88–97.
- Stevens, N. R., Gerhart, J., Goldsmith, R. E., Heath, N. M., Chesney, S. A., & Hobfoll, S. E. (2013). Emotion regulation difficulties, low social support, and interpersonal violence mediate the link between childhood abuse and posttraumatic stress symptoms. *Behavior Therapy*, *44*(1), 152–161.
- Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science*, *10*(1), 121–125.
- van der Kolk, B. A., Roth, S., Pelcovitz, D., Sunday, S., & Spinazzola, J. (2005). Disorders of extreme stress: The empirical foundation of a complex adaptation to trauma. *Journal of Traumatic Stress*, *18*(5), 389–399.
- Wagner, A. W., Roemer, L., Orsillo, S. M., & Litz, B. T. (2003). Emotional experiencing in women with posttraumatic stress disorder: Congruence between facial expressivity and self-report. *Journal of Traumatic Stress*, *16*(1), 67–75.
- Williams, L. M., Kemp, A. H., Felmingham, K., Barton, M., Olivieri, G., Peduto, A.,... Bryant, R. A. (2006). Trauma modulates amygdala and medial prefrontal responses to consciously attended fear. *NeuroImage*, *29*(2), 347–357.