



Negative expectancies in posttraumatic stress disorder: Neurophysiological (N400) and behavioral evidence

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ABSTRACT

Background: Posttraumatic stress disorder (PTSD) is a disorder that theoretically and clinically is thought to be associated with persistent and exaggerated negative expectancies. This study used the N400 event-related potential (ERP) to investigate expectancies for threatening endings to ambiguous sentence stems. The N400 ERP is thought to reflect the amount of effort required to integrate a stimulus into a given context. In sentence reading tasks, the N400 is reliably larger when a word is unexpected.

Method: In this study, fifty-seven trauma survivors of various types (22 with PTSD and 35 without) read ambiguous sentence stems on a computer screen. These sentence stems were completed with either an expected (“The unfortunate man lost his...wallet”), unexpected (“The unfortunate man lost his...artist”), or threatening word endings (“The unfortunate man lost his...leg”).

Results: Participants with PTSD, as compared to those without, showed significantly smaller N400s to threatening sentence endings suggesting enhanced expectancies for threat. Behavioral responses supported this conclusion.

Conclusions: These findings are consistent with the clinical presentation of hypervigilance and proposed revisions to the DSM-V that emphasize persistent and exaggerated negative expectations about one’s self, others, or the world. Relative to earlier behavioral studies, this work further suggests that this expectancy bias occurs automatically and at the early stages of information processing. The discussion focuses on the potential impact of a negative expectancy bias in PTSD and the value of the ambiguous sentence paradigm for studying PTSD as well as other disorders.

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The DSM-IV-TR defines a psychological trauma as a “an event in which the person experienced, witnessed, or was confronted with actual or threatened death or serious injury, or a threat to the physical integrity of self or others” (p.467) (APA, 2000). While most recover, a proportion of those exposed to psychological trauma present with long standing negative psychological consequences. For example, a recent comprehensive study supported by the Rand Corporation reported that approximately fourteen percent of returning veterans from Iraq and Afghanistan are struggling with posttraumatic stress disorder (Tanielian et al., 2008).

For those that do develop a chronic reaction to traumatic events, the impact on their lives is considerable. The effects of trauma can include a range of signs, symptoms, and behaviors that include increased arousal states, avoidant coping strategies, and recurrent

distressing recollections of the event (APA, 2000). Included among these concerns is a tendency to have persistent and exaggerated negative expectations. Over the years, work in the area of negative expectancies has gained theoretical, clinical, and empirical support. Recently, it has been the cognitive model of Ehlers and Clark (2000) that has delineated the nature and effects of negative expectancy biases in trauma survivors. Ehlers and Clark argue that excessive negative appraisals of the trauma contribute to a sense of ongoing, serious threat (p.319). It is a theory that expanded on those of others (Janoff-Bulman, 1989; Foa et al., 1989) that emphasized post trauma cognitions in which the trauma survivors see the world as completely dangerous and the self as completely negative.

Understanding negative appraisals is critical because they appear to be highly correlated with posttraumatic pathology (Smith and Bryant, 2000; Warda and Bryant, 1998; Foa et al., 1999; Ehring et al., 2006; Hatcher et al., 2009; Moser et al., 2007; Karl et al., 2009; Agar et al., 2006) and have been shown to predict

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subsequent PTSD (O'Donnell et al., 2007; Kleim et al., 2007; Ehring et al., 2008; Engelhard et al., 2009, 2002; Dunmore et al., 1999; Ehlers et al., 1998, 2003). In recognition of the central quality of these negative expectancies, the proposed revisions to the Diagnostic and Statistical Manual for the 5th edition include the following proposed symptom, “Persistent and exaggerated negative expectations about one’s self, others, or the world.”

Therefore, characterizing the nature and extent of these negative expectancies remains an important challenge for the field. Event-related potentials, or ERPs, continue to hold promise as a technique that will help elucidate aspects of bias in PTSD. One ERP component that has never been investigated in PTSD is the N400 component, a negative going waveform that peaks approximately 400 ms after stimulus onset and is sensitive to incongruities in semantics and meaning. The N400 has been theorized to index the integration of a stimulus into a given context, with larger N400s occurring to stimuli that require more cognitive effort for integration (Kutas and Federmeier, 2000; Rugg et al., 1994). This effect is believed to occur because context serves to pre activate meaning and facilitates subsequent stimulus processing. When violations of context occur, more effort is needed to retrieve information from semantic memory, resulting in a larger N400.

The N400 effect has been most frequently and most reliably produced to unexpected final words in “garden path” sentences—sentences in which the preceding sentence context greatly constrains the number of choices that might sensibly finish a sentence. It was a garden path sentence paradigm that produced the first recorded N400 to sentences such as “He shaved off his mustache and city” (Kutas and Hillyard, 1980, 1984). Therefore, words that may be harder to process—because they are unexpected in a context—elicit larger amplitude N400s while expected ending elicit small N400s.

Despite its potential, the N400 has not been widely used in the study of psychopathology, schizophrenia excepted (Salisbury et al., 2002; Kiang et al., 2007, 2008; Nestor et al., 1997). There have been some investigations of the N400 in individuals with depressive disorders, however no difference in the amplitude of the N400 have been found in depression to unexpected final words in garden path type sentences (Deldin et al., 2006; Ruchow et al., 2008; Moser et al., 2008). There have been no published N400 studies in anxiety disorders, although Moser and colleagues (Moser et al., 2008) did report differences in a related component (the P600) in low anxious individuals that suggested a positivity bias.

However in recent years (using non clinical samples), the N400 has been found in paradigms that extend beyond the typical garden path approach. N400 amplitude has been shown to vary during semantic priming paradigm (Franklin et al., 2007; Weisbrod et al., 1999; Rugg, 1985) and can be elicited by pictures, environmental sounds, faces, and odors (Kutas, 1997; Van Petten and Rieffelder, 1995; Bobes et al., 1994; Sarfarazi et al., 1999) as long as the semantics of the stimulus is incongruous with the preceding context. Recently, the N400 was shown to index incongruent stereotypes (White et al., 2009), mood/word mismatches (Chung et al., 1996), and rejections words in the context of romance (Zayas et al., 2009).

This broader use of the N400 in non clinical samples suggests new possibilities for clinical investigations. For example, if individuals with PTSD are vigilant for threat, they might maintain different expectations for how ambiguous sentence stems might end. Support for this view comes from in a non-ERP study that showed that veterans with PTSD complete ambiguous sentences stems with military-relevant endings more frequently than veterans without PTSD (Kimble et al., 2002). How might those participants with PTSD respond to ambiguous sentence stems that were completed with word endings that were either expected (i.e.,

The field was littered with trash”), unexpected (“The field was littered with traffic”), or threatening (“The field was littered with bodies”)? In theory, PTSD-related negative expectancies should be reflected in the amplitude of the N400 — with smaller N400s to threatening sentence endings. We tested this hypothesis in the current study.

This study is the first of its kind to use the N400 to investigate negative expectancies in individuals with PTSD. While there have been many ERP, behavioral, and reaction time studies that have investigated attentional bias and hypervigilance in PTSD, these studies have tended to assess attentional bias in the present, not expectancies about outcomes in the future (for reviews see Bar-Haim, 2010; Bar-Haim et al., 2007; Kimble et al., 2009; Mobini and Grant, 2007; Buckley et al., 2000). Assessing these expectancies and negative appraisals are critical as it is these cognitive processes that have reliably predicted posttraumatic pathology. Doing so using ERP's is particularly valuable in that it minimizes fake good or fake bad biases on the part of the participants that could be impacting the validity of the current self report literature. Evidence of negative expectancies in the N400 would indicate biases in the processing stream that are both early and automatic and would suggest that ambiguous circumstances elicit a negativity bias in those with PTSD.

1. Methods

1.1. Participants

Participants for this study were recruited from the community using flyers and newspaper ads placed around Addison, Chittenden and Rutland counties in Vermont. Flyers were posted at local stores and businesses, and American Legion centers within a 50-mile radius of Middlebury College and Norwich University. The flyers and advertisements provided basic information about the study, including monetary compensation for participation, and instructed interested individuals to contact the principle investigator (MK). An initial phone screening, conducted by the PI, took place in order to determine if the interested individual met inclusion criteria. Requirement for participation included that individuals were at least 18 years of age and had experienced a traumatic incident as defined by the Diagnostic and Statistic Manual of Mental Disorders (APA, 2000). Exclusion criteria included head and brain injury, psychosis, epilepsy, impaired hearing, mental retardation, and poor English language abilities. Those with a history of substance abuse within the past year or a history of substance dependence were excluded. Those individuals determined by the PI to be valid participants scheduled appointments with the research team to participate in the study. Over 133 participants were screened. Seventy two were screened out, most frequently for not achieving Criterion A1 and A2 for the PTSD diagnosis. There were 61 participants in total who were invited in and completed the study, however the data from three participants were excluded from the analysis due to poor quality EEG data. A fourth participant was not included due inaccurate behavioral responses indicating a poor understanding of the task. Thirty-two participants (56%) were male, while 25 participants (43.9%) were female. Ages of participants ranged from 18 to 65, and the average age was 36. Average level of education was consistent with “partial college.” Twenty two (38.6%) of the 57 participants had PTSD while 35 (61.4%) did not meet the criteria. Trauma types included combat exposure, motor vehicle accidents, industrial accidents, sexual and physical assault, childhood abuse, natural disaster, natural disaster, and witnessing violent death. Eleven of the twenty two participants with PTSD were on either anxiolytics or antidepressants. One participant in the no-PTSD group was on an SSRI.

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