Alterations in Affective Processing of Attack Images Following September 11, 2001

Article in Journal of Traumatic Stress · October 2011
DOI: 10.1002/jts.20678 · Source: PubMed

4 authors, including:

Ivy F Tso
University of Michigan
22 PUBLICATIONS 320 CITATIONS

Pearl H Chiu
Virginia Polytechnic Institute and State University
21 PUBLICATIONS 616 CITATIONS

Patricia J Deldin
University of Michigan
85 PUBLICATIONS 1,895 CITATIONS

All content following this page was uploaded by Ivy F Tso on 06 December 2016.

The user has requested enhancement of the downloaded file. All in-text references underlined in blue are added to the original document and are linked to publications on ResearchGate, letting you access and read them immediately.
Altered Affective Processing in Subsyndromal Stress Reactions Following September 11, 2001:
Neural Evidence for Dimensional Traumatic Stress Responses

Ivy F. Tso
University of Michigan, Ann Arbor

Pearl H. Chiu and Brooks R. King-Casas
Harvard University and Virginia Tech Carilion Research Institute

Patricia J. Deldin
University of Michigan, Ann Arbor

Author Note
Ivy F. Tso, Department of Psychology, University of Michigan, Ann Arbor; Pearl H. Chiu, VirginiaTech Carilion Research Institute and Department of Psychology, VirginiaTech; Brooks R. King-Casas, Virginia Tech Carilion Research Institute and Department of Psychology, Virginia Tech; Patricia J. Deldin, Department of Psychology, Harvard University, and Department of Psychology, University of Michigan, Ann Arbor.

These data were collected when Pearl H. Chiu, and Brooks R. King-Casas, and Patricia J. Deldin were at Harvard University. This research was supported by faculty start-up funds by Harvard University and University of Michigan (to PJD), and Harvard University Stimson Research funds (to PC and BKC). Correspondence concerning this article should be addressed to Ivy Tso, Department of Psychology, University of Michigan, Ann Arbor, MI 48109. E-mail: ivytso@umich.edu.

This is a preprint of an article published in Tso, I.F., Chiu, P. H., King-Casas, B. R., & Deldin, P. J. (2011) Journal of Traumatic Stress, 24(5):538-45, located at the following URL: http://www.interscience.wiley.com/.
Abstract

The events of September 11, 2001 created unprecedented uncertainty about safety in the United States and created an aftermath with significant psychological impact across the world. This study examined emotional information encoding in 31 healthy individuals whose stress response symptoms ranged from none to a moderate level shortly after the attacks as assessed by the Impact of Event Scale-Revised. Participants viewed attack-related, negative (but attack-irrelevant), and neutral images while their event-related brain potentials (ERPs) were recorded. Attack images elicited enhanced P300 relative to negative and neutral images, and emotional images prompted larger slow waves than neutral images did. Total symptoms were correlated with altered N2, P300, and slow wave responses during valence processing. Specifically, hyperarousal and intrusion symptoms were associated with diminished stimulus discrimination between neutral and unpleasant images; avoidance symptoms were associated with hypervigilance, as suggested by reduced P300 difference between attack and other images and reduced appraisal of attack images as indicated by attenuated slow wave. The findings in this minimally symptomatic sample are compatible with the alterations in cognition in the posttraumatic stress disorder (PTSD) literature and are consistent with a dimensional model of PTSD.
Altered Affective Processing in Subsyndromal Stress Reactions Following September 11, 2001: Neural Evidence for Dimensional Traumatic Stress Responses

The events of September 11, 2001 were an unprecedented terrifying experience which posed tremendous threats to safety in the United States and throughout the world. In response, 8-10% of the residents of New York City (NYC) reported symptoms consistent with a diagnosis of posttraumatic stress disorder (PTSD) and depression (Galea et al., 2002). In another study, over 40% of Americans across the country were reported to experience significant symptoms of stress related to the attacks (Lee, Isaac, & Janca, 2002; Schuster et al., 2002). The dramatic differences in the prevalence rates of PTSD symptoms in these studies is most likely due to the different “cut-points” used by the authors to determine if someone fell into the clinically significant stress response category. Results such as these have led to increasing questions in the field as to whether post-trauma stress responses are better characterized as dimensional or categorical in nature.

Participants in the present study, like the rest of the world, varied in the severity of the reactions to the events of 9/11. However, the current study was implemented in a unique sample of young, unmedicated, well-educated individuals who besides experiencing a range of stress reactions following media exposure to the attacks, do not share a host of confounding variables reported by participants in many studies of PTSD. Therefore, similar findings in these individuals as those typically found in the PTSD literature would provide support to the notion of dimensional rather than categorical traumatic stress responses.

This study was conducted within one week following 9/11, to determine how the events affected the way otherwise healthy individuals encode emotional information and if neural correlates (event-related potentials, ERPs) of altered valence processing were related to specific
stress symptoms. ERP responses were prompted using affective pictures—attack-related, negative (but attack-irrelevant), and neutral images. Below we review three ERP components elicited during affective picture processing that may enhance our understanding of the cognitive effects of exposure to highly stressful events.

N200

N200 (or N2), a negative-going wave peaking at around 200 ms after stimulus presentation, is generally thought to reflect early attention allocated to stimulus discrimination (Näätänen, 1982). In affective picture paradigms, N2 is also related to valence of the stimuli, such that unpleasant images elicit reduced N2 amplitude compared to pleasant or neutral images (Carretie, Hinojosa, Martin-Loeches, Mercado, & Tapia, 2004; Moser, Hupper, Duval, & Simons, 2008; Silvert, Nobre, Fragopanagos, Taylor & Eimer, 2007). N2 in the PTSD literature has been studied most often using auditory paradigms, where N2 for neutral targets is generally found to be delayed, suggesting slower stimulus discrimination (e.g., Felmingham, Bryant, Kendall, & Gordon, 2002; Galletly, Clark, McFarlane, & Weber, 2001; McFarlane, Weber, & Clark, 1993; Metzger et al., 2009). Visual N2 data in anxiety and PTSD are scarce, though normal N2 amplitude has been reported in an emotionally neutral sustained attention task (Shucard, McCabe, & Szymanski, 2008), while others have reported diminished N2 modulation by threat stimuli in high anxious subjects (Dennis & Chen, 2009), suggesting that attention may be attenuated as a defensive response in PTSD, resulting in emotional numbing (Menning, Renz, Seifert, & Maercker, 2008). These data are consistent with the behavioral findings that performance of participants with PTSD is compromised when emotional stimuli are used (see Banich et al., 2009 for a review). More N2 data are needed to evaluate the affective modulation of early attention in traumatic stress reactions and its relationship with specific symptoms.
P300/Late Positive Potential (LPP)

P300, a positive-going wave occurring around 300 ms after stimulus onset, is thought to index attention (P3a, over fronto-central region) and task-relevant memory update (P3b, over parietal region; Polich, 2007). P300 elicited by images is often coupled with a later, sustained positivity and together referred to as the late positive potential (LPP). P300/LPP is consistently larger to emotional than neutral pictures (Amrhein, Muhlberger, Pauli, & Wiedemann, 2004; Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000). The affective P300/LPP effect is typically maximal over the parietal region and significantly correlated with hemodynamic activity in visual cortical structures (Sabatinelli, Lang, Keil, & Bradley, 2007). This leads researchers to believe that emotional images are processed automatically and can be considered natural “targets” in the visual scene due to their intrinsic motivational significance (see Hajcak, McNamara, & Olvet, 2010).

The large body of P300 literature in PTSD comprises mostly studies using oddball paradigms. The general finding highlights the importance of emotional information processing in PTSD: individuals with PTSD show reduced P3b to targets in non-emotional contexts but enhanced P3b to neutral targets when the distractors contain trauma-related or threatening information (see Karl, Malta, & Maercker, 2006 for a review). In other words, when the context is perceived as innocuous, mental resources for updating short-term memory are reduced. However, in the face of possible threat, mental resources are indiscriminately increased to monitor threat. This may explain the clinical observation of general attention deficit and hypervigilance in PTSD.

There is some evidence that abnormal P3 responses are related to specific PTSD symptoms. For example, individuals with more severe numbing symptoms showed reduced
overall P300 responses (Felmingham et al., 2002), whereas individuals high in hyperarousal and re-experiencing symptoms exhibited enhanced P300 to distractors (Shucard et al., 2008). It remains to be demonstrated whether previous P3 findings in PTSD and anxiety disorders can be generalized across tasks and perceptual modalities.

**Slow Wave (SW)**

SW, a late-latency ERP component thought to index more controlled, elaborative cognitive operations such as mental rehearsal (Ruchkin, Johnson, Grafman, Canoune, & Ritter, 1992). For example, in a stimulus discrimination paradigm, positive SW—particularly over frontal and parietal regions—reflects updating and rehearsal of working memory stores (Clark, Orr, Wright, & Weber, 1998). SW in image viewing paradigms occurs after 500 ms post-stimulus onset and can last at least up to 6 s. Affective images elicit increased SW positivity compared to neutral images. Because elevated SW prompted by affective pictures is correlated with later better recall of these pictures (Dolcos & Cabeza, 2002), SW is suggested to index mental rehearsal required for memory formation. The affective effect on SW is subject to the influences of top-down processes such as appraisal strategy (Hajcak, Moser, & Simons, 2006) and suppression of emotional reactions (Moser, Hajcak, Bukay, & Simons, 2006). SW data in PTSD are scarce, most likely due to the prevalent use of brief stimulus presentation and short time epochs for ERP analyses. The only study we are aware of is Galletly et al. (2001), which found decreased frontal and posterior SW to targets and non-targets in a tone discrimination task among individuals with PTSD, suggesting disrupted executive processes and memory formation of affectively neutral information. Demonstrating a relationship between reduced SW during emotional information processing and specific stress symptoms would provide a better neurophysiological understanding of altered mental operations caused by trauma exposure.
The present study

It was hypothesized that attack, negative, and neutral images would elicit differential N2, P300, and SW responses due to their differences in valence and arousal levels. Further, ERPs elicited by affective images, particularly attack images, would be correlated with overall and specific stress symptom clusters (intrusion, avoidance, and hyperarousal) as measured with the IES-R scale.

Method

Participants

A sample of university students not directly affected by the attacks (i.e., no immediate family or close friends involved) were recruited for this study within one week following September 11, 2001. This was the first week of the academic year, and participants were recruited as part of a larger event for students interested in psychology studies. Participants with major medical illness, history of mental illness, or on psychotropic medications were excluded using a screening questionnaire. Written informed consent was obtained from each participant after information of the study was provided in detail.

Task Design

The passive picture-viewing task used in this study contained 90 images presented in a randomized order, each presented for 2 s with an inter-stimulus interval of 12-18 s. Thirty of the images were “attack” pictures (images taken from the media and directly related to the events of 9/11); 30 “negative” (images of other conflicts and natural disasters displayed in the contemporary media and not related to the events of 9/11); and 30 “neutral” (taken from the International Affective Picture System, IAPS; Lang, Ohman, & Vaitl, 1988). Due to the limited amount of time and pool of 9/11-related images available at the time, image characteristics (e.g.,
color, complexity, presence of people) were not explicitly matched between the three categories of images; both the “attack” and “negative” stimuli contained a range of complex images with and without people.

**Procedure**

Before the ERP experiment, participants completed the Impact of Event Scale-Revised (IES-R; Weiss & Marmar, 1997), modified for the events of 9/11, and the Beck Depression Inventory (BDI; Beck, Steer, & Brown, 1996). Then, their EEG was recorded during viewing of the affective pictures. Following the EEG session, participants rated the valence (1 = *pleasant* and 9 = *unpleasant*) and arousal (1 = *calm* and 9 = *aroused*) of each of the images using the Self Assessment Manikin (SAM; Bradley & Lang, 1994).

**Electrophysiological Data Acquisition and Reduction**

Electroencephalogram (EEG) was recorded from frontal (F3, F4, Fz), central (C3, C4, Cz), and parietal (P3, P4, Pz) sites using a Lycra stretchable cap (Electro-Cap International Inc., Eaton, OH) with Ag/AgCl electrodes positioned according to the International 10-20 system. Electro-oculogram (EOG) data were recorded from electrodes placed lateral to the outer canthi and at the left supraorbital and suborbital positions. Electrode impedances were kept below 5 kΩ. EEG was referenced to the left mastoid (M1) and re-referenced to average mastoids off-line ([M1+M2]/2). EEG signals were amplified with a 37/64 channel amplifier (SA Instruments) and were digitally sampled at the rate of 2000 Hz with a high-pass analog filter at 0.01 Hz and low-pass at 100 Hz.

EEG data reduction was conducted using BrainAnalyzer software (BrainVision, Gmbh). Data were segmented into 2.5-s epochs (500 ms baseline, 2000 ms post-stimulus) with respect to the stimulus onset. This was followed by the application of a 60-Hz notch filter and correction of
eye-blink artifact using the Gratton, Coles, & Donchin (1983) regression algorithm. Individual trials exceeding +/- 80 μV were automatically rejected. Data were subsequently subjected to visual inspection and manually scored to remove remaining artifact. Data were then baseline adjusted, and averaged across trials for each valence conditions (attack, negative, neutral).

ERP components were identified based on a literature review and principal component analysis (PCA) with an extraction criterion of eigenvalue > 1 and Varimax rotation. An ERP component was defined as a contiguous set of points with factor loadings equal or larger than 0.6 on a single principal component. Three distinctive ERP components were identified: N2 (150-340 ms), P300 (340-820 ms), and SW (820-2000 ms). Mean PCA score (i.e., product of brain potentials and component loadings) of each of these ERP components was used in analyses.

Statistical Analyses

Valence and arousal ratings of the images were analyzed separately using repeated-measures analysis of variance (ANOVA), with stimulus valence (attack, negative, neutral) as the within-subjects variable.

N200 was analyzed with a 3 (Valence: attack, negative, neutral) × 3 (Laterality: F3, Fz, F4) repeated-measures ANOVA. P300 was analyzed in the same manner, except that parietal (P3, Pz, P4) instead of frontal sites were used (Cuthbert et al., 2000). For slow wave, because it is unclear from the literature whether it has a specific topographic distribution for this paradigm, a 3-way 3 (Valence: attack, negative, neutral) × 3 (Laterality: left, midline, right) × 3 (Caudality: frontal, central, parietal) repeated-measures ANOVA was performed. For all ANOVAs, Huynh-Feldt adjustment was used in case of violation of the assumption of sphericity.

Relations between these ERP measures and stress symptom clusters (as on the IES-R) were examined with Pearson correlations.
Results

Demographics and Stress Symptoms

A total of 31 university students (17 women, 14 men; 28 right-handed, 3 left-handed) completed the experiment. All of the participants were college students in Boston, MA recruited during the first week of the school calendar. Therefore, exposure to the events was limited to media coverage and exchanges with others not directly affected by the attacks. Distress related to the attacks ranged from minimal to moderate—their total IES-R scores ranged from 5 to 41 ($M = 20.35, SD = 10.33$). The ranges of scores for the three IES-R subscales were: Intrusion 1 to 16 ($M = 8.45, SD = 4.24$), Avoidance 2 to 18 ($M = 8.31, SD = 4.88$), and Hyperarousal 0 to 10 ($M = 3.59, SD = 3.12$). BDI scores ranged from 0 to 14 ($M = 5.36, SD = 3.53$).

Valence and Arousal Ratings

Participants rated the attack images ($M = 7.02, SD = 0.84$) as more unpleasant than the negative images ($M = 6.72, SD = 0.91$), which were in turn rated as more unpleasant than the neutral images ($M = 4.90, SD = 0.70$), $F(1.24, 33.49) = 61.98, p < .001$, partial $\eta^2 = .70$.

Participants rated the attack ($M = 6.40, SD = 1.28$) and negative images ($M = 6.27, SD = 1.15$) as more arousing than the neutral images ($M = 3.23, SD = 1.62$), $F(1.23, 33.88) = 72.18, p < .001$, partial $\eta^2 = .73$; attack and negative images were not statistically different in arousal rating.

ERP Results

Grand average waveforms at each of the nine sites in the attack, negative, and neutral conditions are presented in Figure 1.

N200. N2 responses were not different across valence conditions, $F(2, 60) = 0.23, p = .794$, but were lateralized to the right ($M = -3.18, SD = 2.78$), $F(2, 60) = 5.10, p = .009$, partial $\eta^2$
= .15, with no significant difference (p = .906) between left (M = -2.57, SD = 2.68) and midline N2 (M = -2.54, SD = 2.64). The Valence × Laterality interaction was not significant.

**P300.** There was a strong valence effect, $F(2, 60) = 8.77, p < .001$, partial $\eta^2 = .23$, where P300 response to attack images (M = 7.71, SD = 3.84) was larger than negative (M = 6.56, SD = 4.43) and neutral images (M = 5.75, SD = 4.07); negative and neutral images were not different (p = .109). While P300 did not show an overall laterality effect, $F(2, 60) = 1.54, p = .222$, there was a Valence × Laterality interaction, $F(4, 120) = 3.77, p = .006$. Post-hoc analyses revealed that emotional images (attack and negative) elicited larger P300 over the left hemisphere than neutral images did, and attack images elicited larger P300 at midline and right sites than attack-irrelevant (negative and neutral) images. See Figure 2.

**Slow wave.** SW also showed a strong valence effect, $F(2, 60) = 7.25, p = .002$, partial $\eta^2 = .20$. However, unlike the P300 valence effect, both attack (M = 5.18, SD = 3.69) and negative images (M = 4.61, SD = 3.05) elicited larger SW than neutral images (M = 2.88, SD = 4.08) did (p = .001 and .016), with no statistical difference between the two emotional conditions (p = .320). Neither of the laterality and caudality effects, nor any of the interactions between the within-subjects factors was significant.

**Correlations between ERP Measures and Stress Symptom Clusters**

Stress symptom clusters on the IES-R were correlated with ERP (frontal N2, parietal P300, and average SW across electrode sites) in each of the valence conditions (attack, negative, neutral) as well as ERP differences between each of the emotional conditions and the neutral condition (i.e., attack minus neutral, negative minus neutral, attack minus negative). The results are displayed in Table 1.
Intrusion was inversely correlated with N2 negativity to neutral images and with neutral-minus-attack and neutral-minus-negative N2 differences. In other words, participants with more intrusion symptoms tended to show more N2 negativity to unpleasant stimuli than neutral stimuli, which was likely due to their decreased N2 response to neutral stimuli.

Avoidance was significantly correlated with decreased attack-minus-neutral and attack-minus-negative P300, decreased SW response to attack images, and decreased attack-minus-neutral SW.

Hyperarousal was significantly correlated with decreased N2 negativity to neutral images.

Total IES-R score was correlated with decreased N2 negativity to neutral images, and decreased neutral-minus-attack and neutral-minus-negative N2 negativity. Total IES-R was also associated with decreased attack-minus-neutral P300 and SW.

Finally, IES-R symptoms were not correlated with valence and arousal ratings (all p’s > .15), and BDI score was not correlated with ERP measures (all p’s > .10).

Discussion

This study examined neural correlates of emotional information processing in a group of healthy individuals showing minimal to moderate post-9/11 distress reactions. The results indicate that psychophysiological responses during valence processing were related to distress level. The stress-related psychophysiological deviations included: 1) diminished stimulus discrimination between unpleasant and neutral stimuli, as suggested by the reduced N2 difference between unpleasant and neutral images; 2) hypervigilant memory update, as suggested by the reduced P300 difference between unpleasant and neutral images, likely due to the
increased P300 to neutral images; and 3) reduced appraisal of trauma-related images, as suggested by the attenuated SW to attack images. These deviations are analogous to the clinical phenomena and abnormal cognition observed in individuals with PTSD (Karl et al., 2006; Shipherd & Beck, 2005). Given that the participants in this study were young, unmedicated, highly functional individuals and their distress reactions did not reach clinical threshold, this finding suggests that normal stress reactions or subsyndromal PTSD to extreme stressors may differ from PTSD only quantitatively but not qualitatively. This is consistent with the thesis of dimensional PTSD that PTSD may be more appropriately conceptualized as reactions to stressful life events that represent the upper end of a stress-response continuum rather than a discrete clinical syndrome (Broman-Fulks et al., 2006; Ruscio, Ruscio, & Keane, 2002).

In this study, N2 negativity did not show a valence effect, contrary to the common finding that neutral/pleasant images elicit larger N2 response than unpleasant images among healthy individuals (Carretie, Hinojosa, et al., 2004; Carretie, Mercado, Hinojosa, Martin-Loeches, & Sotillo, 2004; Silvert et al., 2007). This was likely due to the decreased N2 negativity to neutral images in those with higher stress reactions, particularly intrusion and hypersousal symptoms. The correlation between reduced neutral-minus-unpleasant N2 difference and severity of stress reactions found in this study suggests that the normal attentional bias away from negative events (Bradley et al., 1997; Deldin, Keller, Gergen, & Miller, 2001) disappears as stress reactions become stronger. This is consistent with the neuroimaging finding (Bremner et al., 2004; Shin et al., 2001) that individuals with PTSD fail to recruit the anterior cingulate cortex (ACC)—a brain region to where the N2 response to affective images has been localized (Carretie, Mercado, et al., 2004)—to direct attention away from threats. This altered attentional process in subsyndromal hyperarousal and intrusion stress reactions may be analogous to the
early protective inhibition for the sensitive nervous system in some individuals with PTSD suggested by Lewine et al. (2002). This potentially protective mechanism, nevertheless, may contribute to the maintenance of trauma-related stress symptoms, as it impairs one’s ability to discriminate benign events from threatening ones, thus limiting the opportunity to develop positive emotions and to unlearn the associations between neutral stimuli and trauma memories. Executing cognitive control to redirect attentional resources to benign information may be a critical way to recover from maladaptive PTS reactions.

Attack images elicited substantially larger P300 response than both negative and neutral images. This was not surprising given that the attack images were rated as most unpleasant and arousing (Cuthbert et al., 2000). However, although negative images were rated as more unpleasant and arousing than neutral images, the magnitudes of P300 response elicited by these two types of images were not significantly different. Thus, there appeared to be a complex interaction between valence and arousal on P300; P300 response in this study may be appropriately thought to index the perceived salience of the stimuli. Obviously, the attack images were likely highly significant and anxiety-provoking to the participants given the recency of 9/11 at that time. However, the positive relationship between P300 response and stimulus salience weakened with higher stress reactions; P300 response to neutral images was increased as stress reactions were more severe. This indicates active memory update despite the trauma-irrelevant nature of the current information, analogous to hypervigilance observed in PTSD. Such a hyperactive signal detection system results in unnecessary contextual updating. While hypervigilance may be protective in some situations, in the long run it taxes the individual through indiscriminate memory update, which potentially exhausts mental resources and results
in an inability to protect self from danger and retraumatizing activities (cf. Orcutt, Erikson, & Wolfe, 2002).

Participants showed larger SW responses to attack and negative than neutral images, consistent with the literature that arousing visual material elicits more positive-going SW (see Olofsson, Nordin, Sequeira, & Polich, 2008 for a review). However, as avoidance stress symptoms increased, SW to attack images decreased. It has been shown that affective effect on SW is subject to the influences of top-down processes such as appraisal strategy (Hajcak, Moser, & Simons, 2006) and suppression of emotional reactions (Moser, Hajcak, Bukay, & Simons, 2006). The reduced SW response to attack images in those with higher avoidance symptoms may be analogous to thought suppression or avoidance of appraisal of trauma-related information, a maladaptive coping strategy commonly observed in PTSD. It should be noted that because the image characteristics of the attack images were not able to be explicitly matched with the neutral and negative pictures, this finding should be interpreted with caution and further investigation is warranted.

Finally, the finding that different stress symptom clusters, but not symptoms of depression, showed different affective ERP correlates confirmed the importance of examining emotional information processing in the investigation of stress reactions. Also, specific stress symptom clusters were significantly correlated with ERP measures but not self-report valence and arousal ratings of the stimuli, providing further support for the value of psychophysiological measures in this investigation.

This study has several limitations, including small sample size, use of exclusively college students, and uncorrected multiple comparisons/correlations. Replications using well-matched stimuli and a larger and more representative samples, including participants with a wider range
AFFECTIVE PROCESSING IN SUBSYNDROMAL STRESS

(from minimal to clinical PTSD) of stress reactions, would help confirm the ERP correlates of specific stress symptom clusters and strengthen the claim of dimensional PTSD. Inclusion of a control group (e.g., depression) would also help to test if the findings are trauma-specific.
References


AFFECTIVE PROCESSING IN SUBSYNDROMAL STRESS


[Photographic slides]. Gainseville, FL: The Center for Research in Psychophysiology,
University of Florida.

Opinion in Psychiatry, 15(6), 633-637.

Abnormal stimulus-response intensity functions in posttraumatic stress disorder: An
doi: 10.1176/appi.ajp.159.10.1689

3223(93)90088-U

posttraumatic stress disorder: A compensatory mechanism for chronic hyperarousal?
International Journal of Psychophysiology, 68(1), 27-34. doi:
10.1016/j.ijpsycho.2007.12.003

discordant for combat: Association with PTSD. Psychophysiology, 46(1), 172-178. doi:
10.1111/j.1469-8986.2008.00720.x

emotional responding to unpleasant pictures: An ERP study. Psychophysiology, 43, 292–


AFFECTIVE PROCESSING IN SUBSYNDROMAL STRESS


Table 1

Correlations between IES-R Stress Symptom Clusters and ERP Measures

<table>
<thead>
<tr>
<th>IES-R Score</th>
<th>Intrusion</th>
<th>Avoidance</th>
<th>Hyperarousal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attack</td>
<td>-.04</td>
<td>.04</td>
<td>-.21</td>
<td>-.06</td>
</tr>
<tr>
<td>Negative</td>
<td>-.17</td>
<td>-.07</td>
<td>-.34</td>
<td>-.21</td>
</tr>
<tr>
<td>Neutral</td>
<td>-.41*</td>
<td>-.19</td>
<td>-.45*</td>
<td>-.40*</td>
</tr>
<tr>
<td>Neutral-Attack&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.43*</td>
<td>-.25</td>
<td>-.33</td>
<td>-.39*</td>
</tr>
<tr>
<td>Neutral-Negative&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.45*</td>
<td>-.22</td>
<td>-.28</td>
<td>-.37*</td>
</tr>
<tr>
<td>Negative-Attack&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-.14</td>
<td>-.11</td>
<td>-.15</td>
<td>-.16</td>
</tr>
<tr>
<td><strong>P300</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attack</td>
<td>.07</td>
<td>-.02</td>
<td>.03</td>
<td>.03</td>
</tr>
<tr>
<td>Negative</td>
<td>.05</td>
<td>.18</td>
<td>.06</td>
<td>.13</td>
</tr>
<tr>
<td>Neutral</td>
<td>.23</td>
<td>.30</td>
<td>.22</td>
<td>.30</td>
</tr>
<tr>
<td>Attack-Neutral</td>
<td>-.26</td>
<td>-.49**</td>
<td>-.29</td>
<td>-.42*</td>
</tr>
<tr>
<td>Negative-Neutral</td>
<td>-.26</td>
<td>-.15</td>
<td>-.23</td>
<td>-.25</td>
</tr>
<tr>
<td>Attack-Negative</td>
<td>.01</td>
<td>-.36*</td>
<td>-.06</td>
<td>-.19</td>
</tr>
<tr>
<td><strong>SW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attack</td>
<td>-.22</td>
<td>-.36*</td>
<td>-.09</td>
<td>-.29</td>
</tr>
<tr>
<td>Negative</td>
<td>-.24</td>
<td>-.07</td>
<td>-.14</td>
<td>-.17</td>
</tr>
<tr>
<td>Neutral</td>
<td>-.08</td>
<td>.12</td>
<td>.13</td>
<td>.06</td>
</tr>
<tr>
<td>Attack-Neutral</td>
<td>-.14</td>
<td>-.50**</td>
<td>-.24</td>
<td>-.37*</td>
</tr>
<tr>
<td>Negative-Neutral</td>
<td>-.11</td>
<td>-.18</td>
<td>-.25</td>
<td>-.20</td>
</tr>
<tr>
<td>Attack-Negative</td>
<td>-.02</td>
<td>-.35</td>
<td>.02</td>
<td>-.17</td>
</tr>
</tbody>
</table>

a. For ease of interpretation, the sign of N2 was reversed in the computation of correlations, so

that positive correlations indicate that higher symptom score is associated with increased N2 negativity.

b. Because N2 negativity, unlike P300 and SW, is normally larger to pleasant/neutral than to unpleasant stimuli, Neutral-Attack instead of Attack-Neutral (and similarly for differences between other valence conditions) was used in computing symptom correlations with N2.

* *p < .05     ** *p < .01
Figure 1. Event-related potentials evoked by Attack, Negative, and Neutral images. Stimulus onset occurred at 0 ms. Electrodes are displayed from most anterior (top) to most posterior (bottom) and from left to right at they were positioned on the scalp.
Figure 2. Valence × Laterality interaction of parietal P300 responses.

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