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Contents

Security-Priming in Trauma-Exposed Individuals: a Functional Magnetic Resonance Imaging (fMRI) Study

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Abstract

Research shows a strong association between attentional bias to threat and emotional regulation difficulties, specifically heightened activation of neural areas known to be involved in emotional processing (amygdala) in individuals who report post-traumatic stress symptoms. Theoretical and research evidence suggests that the enhancing of felt attachment security through security-priming may grant an individual access to effective emotion regulation strategies, which in turn may reduce attentional bias and associated abnormal neural activations.

Trauma-survivors with elevated anxiety levels were randomised into an experimental group (secure attachment priming, *n*=16) where they were primed using positive attachment-related pictures, or a neutral control priming condition (*n*=18) where they viewed non-attachment pictures of people. Participants then completed a dot-probe task to measure attentional bias to threat, and an emotionally threatening face-matching task to probe amygdala activation.

No between groups differences were found on measures of attentional bias. Contrary to the hypothesis, participants in the security-priming group showed significantly greater amygdala activation in response to threatening faces. Attachment style was not found to moderate the impact of security-priming on attentional bias or neural activation.

Interpersonal trauma experiences make up the majority of the study sample. The impact of this is considered in the context of short-term single exposure to explicit attachment based security-priming interventions and the study paradigm employed to measure amygdala activation, which may act to initially dysregulate and contraindicate activation of a secure attachment representation, respectively.

Following exposure to a *traumatic stressor*[1], it is estimated that between 8-30% of individuals will go onto develop symptoms of post-traumatic stress disorder (PTSD), (Breslau et al., 1991; Kessler et al., 1995). PTSD is characterised by three major symptom clusters: the persistent re-experiencing of a traumatic event (e.g. intrusive thoughts and images), autonomic, affective and cognitive hyper-arousal (e.g. hyper-vigilance to threat), and avoidance and emotional numbing symptoms (American Psychiatric Association, 2000).

PTSD is related to and maintained by maladaptive cognitive processes including 'attentional bias' (AB) to threatening stimuli. This is where a threatening stimulus acts to disrupt an individual's cognitive activities due to an involuntary re-allocation of resource-limited attention to that stimulus, whereby individuals attend more readily to threat-related stimuli compared to neutral stimuli (Constans, 2005). This results in an increased reactivity and hyper-vigilance to threat cues in the environment, which, along with avoidance behaviours, often prevents safety learning[2] (Ehlers & Clark, 2000) and has been indicated in the maintenance of PTSD symptoms (El Khoury-Malhame et al., 2011a).

PTSD is known to be associated with ineffective emotion regulation, specifically, the inability to learn and autonomously achieve feelings of safety, with sufferers often oscillating between experiences of hyper-arousal and emotional numbing (Lanius, Bluhm, & Frewen, 2011). AB and abnormal activation in the neural centres such as the amygdala (Rougemont-Bucking et al. 2011), are proposed to contribute to the emotional dysregulation found in symptomatic trauma-exposed individuals.

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[1] Whereby an individual has experienced or witnessed an event or series of events that involved an actual or threatened death, or serious injury, or a threat to the physical integrity of self or others" (American Psychiatric Association, 2000, p.200). This may include sudden personal injury or a serious accident, a physical assault, act(s) of abuse, witnessing the death or serious injury of another individual, news of an unexpected and sudden death or serious injury to a relative or friend, a rape, natural disaster, amongst others (Joseph, Williams, & Yule, 1997).

[2] A reduction in the fear response when the objective danger is over, and acts to maintain trauma symptomology (Ehlers & Clark, 2000).

Further research is required to provide behavioural and neural evidence of ways to help trauma-survivors learn safety. Recent developments in the field of attachment security-priming in anxiety disorders–whereby feelings of felt attachment security are temporarily induced, may offer a novel way to facilitate access to more effective emotion regulation strategies in PTSD symptomatic trauma-exposed individuals.

Attentional Bias and Neural Dysregulation in Trauma-Exposed Individuals

AB is commonly measured using experimental paradigms such as the dot-probe task (Mogg & Bradley, 1999), where presence of an AB is determined by comparing the speed of participants' behavioural responses to a visual probe which follows threatening and neutral word stimuli. A large number of experimental studies using AB paradigms (Cisler & Koster, 2010) have found that individuals with anxiety disorders, most notably PTSD, demonstrate an AB toward threat-related stimuli (Ashley et al., 2013; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Beck, Freeman, Shipherd, Hamblen, & Lackner, 2001; Bryant & Harvey, 1997; Buckley, Blanchard, & Neill, 2000; Buckley, Blanchard, & Hickling, 2002; Fani et al., 2012; McNally, Kaspi, Bradley, & Zeitlin, 1990; McNally, 1998; McNally, 2006).

These changes in attentional processing have been found to be associated with altered neural activations involving a hyper-responsive amygdala, which is involved in the processing of threatening stimuli, whereby traumatised individuals exhibit increased amygdala responses to threatening stimuli (Etkin & Wager, 2007; Garfinkel & Liberzon, 2009; Shin & Liberzon, 2010). Accordingly, amygdala response is reported to positively correlate with AB in PTSD patients (El Khoury-Malhame et al., 2011b).

The scientific evidence remains largely unclear as to whether AB and heightened amygdala activity act as a risk factor for post-traumatic stress, or the position that these phenomena are concomitant cognitive and neural manifestations that arise as a result of a post-

traumatic stress response. A diminished AB has been found to be associated with amelioration of post-traumatic stress symptoms (El Khoury-Malhame et al., 2011a), and AB has been shown to be strongly positively correlated with amygdala activity (El Khoury-Malhame et al., 2011b). Furthermore, PTSD treatment studies have shown that symptom reduction in response to psychotherapy in PTSD patients is associated with decreased amygdala activation (Peres et al., 2007). This may provide preliminary evidence which lends support to the latter position.

Reviews of animal models and human neuroimaging studies suggest that the exaggerated neural response to threat-stimuli exhibited by amygdala is strongly associated with emotional regulation difficulties, that is, the dysregulation of negative affect (Hayes, Hayes, & Mikedis, 2012; Liberzon & Sripada, 2008), and is likely to represent an important mechanism which maintains trauma symptomology.

Furthermore, behavioural (Fani et al., 2012) and fMRI research (Rougemont-Bucking et al., 2011) has demonstrated that traumatised individuals often fail to learn safety due to heightened emotional arousal which impairs fear extinction processes. To date, it is not well understood how AB to threat can be reduced and feelings of safety can be enhanced in trauma patients. The findings from the above studies would suggest that interventions which focus on reducing the hyper-activity in the threat-sensitive amygdala would offer a potential reduction in the associated AB to threat. Attachment security-priming (SP) offers one potential way of achieving this.

Attachment Security and Emotional Regulation

Attachment theory (Bowlby, 1973; Bowlby, 1982) posits that during childhood, patterns of social interactions with attachment figures are internalised in the form of conscious and unconscious mental representations of the self and relationship partners, referred to as a person's internal working model (IWM). Social experiences with attachment figures act to shape and define the parameters of an individual's IWM resulting in relatively stable

individual differences in attachment styles[3], resulting in specific emotion regulation strategies (Main, Kaplan, & Cassidy, 1985).

Individuals with a history of access to consistently emotionally available and responsive attachment figures–who would facilitate the efficient restoration of normal affect and feelings of security through enactment of what Main (1990) refers to as the *primary attachment strategy*, are likely to go onto develop a positive IWM; that is, a secure global attachment style, in which the world is generally safe, attachment figures are attentive and caring, and support is available when it is required.

Individuals under the care of an attachment figure who is not consistently available at times of need are likely to internalise negative dominant IWMs: that is, an insecure global attachment style, in which the world is unsafe, in which he or she is isolated and uncared for, and where help from others is unavailable or not to be relied upon (Mikulincer & Shaver, 2004). These individuals are likely to recruit compensatory *secondary attachment strategies* in their emotion regulation consisting of hyper-activation (up-regulation of attachment behaviours: e.g. hyper-vigilance to rejection, longing for close emotional bonds) or deactivation (down-regulation of attachment behaviours: e.g. suppressing the need for close emotional bonds) of the attachment system (refer to Main, 1990; Mikulincer & Orbach, 1995). These strategies closely marry to the two dimensions used to conceptualise and measure attachment security; attachment anxiety[4] and attachment avoidance[5], respectively (Brennan,

[3] A pattern of generalised expectations, emotions, beliefs about the self, the world, others and relationships with significant others that arise from an individual's attachment history (Cassidy & Shaver, 2008).

[4] High attachment anxiety is marked by fear of abandonment and rejection by a significant other, and low self-worth to other people. Scores reflect the degree to which a person relies on hyper-activating strategies.

[5] High attachment avoidance is represented by discomfort with closeness to others and reluctance to depend on relationship partners. Scores reflect the degree to which a person relies on deactivating attachment strategies. (Brennan, Clark, & Shaver, 1998)

Clark, & Shaver, 1998). Individuals who achieve low scores on both of these dimensions can be said to possess a secure attachment style.

The early attachment relationship is thought to lay the foundation for learning emotional self-regulation (Cassidy, 1994; Calkins, 2004), that is, the ability to modulate one's own emotional experience and cope with arousal to maintain functional, but not debilitating levels of emotion (Cole, Martin, & Dennis, 2004), and crucially one's ability to successfully regulate negative affect and arousal by enacting the primary attachment strategy (Sbarra & Hazan, 2008; Selcuk, Zayas, & Hazan, 2010; Thompson, 2008).

Mikulincer & Shaver (2003) have proposed a model of attachment-system dynamics in adulthood which elucidates how adults with different global attachment styles may regulate affect (refer to Appendix 1). The model outlines how when faced with a physical or psychological threat, an individual's perceived availability of attachment figures determines their use of the primary or secondary attachment affect regulation strategies. This leads to the implementation of strategies that are likely to be congruent with their dominant attachment style. If the individual appraises that attachment figures are available and responsive, the individual successfully employs the primary attachment strategy aimed to alleviate distress, maintain supportive relationships, and bolster the individual's sense of love-worthiness and self-efficacy. Conversely, if the individual perceives an attachment figure to be unavailable or unresponsive to their needs, than they go on to employ generally less successful secondary attachment emotion regulation strategies.

The model emphasizes the importance of the appraisal of an available and responsive attachment figure when a threat is perceived by an individual, for the facilitation of effective emotional regulation strategies to help restore an individual's felt-security and emotional equanimity. This is also reflected in Coan's work (Coan, 2008; Coan, 2010), who refers to the

'social regulation of threat' whereby perceived availability of attachment figures determines level of threat and emotional security.

Mikulincer and Shaver's model is supported by neuroimaging research which demonstrates significant associations between insecure attachment style and exaggerated neural activation in threat-processing centres in response to threatening stimuli in healthy control samples (Buchheim et al., 2006; Lemche et al., 2005; Vrtička, Andersson, Grandjean, Sander, & Vuilleumier, 2008; Vrtička, Bondolfi, Sander, & Vuilleumier, 2012).

Research has also robustly shown that possessing a secure attachment style acts as a resilience factor in how well individuals manage post-traumatic stress, whereby more securely attached individuals are found to employ more successful emotion regulation strategies to restore their internal world to a state of equanimity (Lanius et al., 2011), and exhibit less severe trauma symptoms (Dekel, Soloman, Ginzburg, & Neira, 2004; Kanninen, Punamaki, & Qouta, 2003).

Attachment SP offers a potential way of increasing the perceived availability of attachment figures to facilitate more adaptive emotional regulation strategies in traumatised individuals.

Attachment Security-Priming

It is thought that everyone possesses secure attachment mental representations which facilitate access to the primary attachment strategy regardless of their dominant attachment style (Baldwin, Keelan, Fehr, Enns, & Koh-Rangarajoo, 1996). A person's dominant attachment style is thought to be just the most accessible node in a complex hierarchical mental network of attachment-related thoughts, thus allowing the potential for different IWMs to be activated corresponding to different kinds of attachment experiences though cognitive

processes of spreading activation[6] (Mikulincer & Shaver, 2007b). Advances in the study of attachment processes have found that showing individuals positive attachment relationship oriented stimuli using 'security-priming' methodologies (Gillath, Selcuk, & Shaver, 2008) acts to temporarily increase feelings of emotional security (i.e. felt-security).

SP involves making a secure attachment relationship or figure consciously or unconsciously salient to an individual using an attachment SP stimulus (e.g. pictures, words) before they complete a task. SP makes mental representations of attachment figures symbolically available at Mikulincer & Shaver's appraisal level of their adult attachment model, and is believed to help facilitate the primary attachment strategy to augment a person's sense of felt-security and act to help restore and maintain an individual's emotional equanimity (Mikulincer & Shaver, 2007a). SP is theorised to be effective for people regardless of their dominant attachment style through the potential to activate secure IWMs that may be incongruent with their dominant attachment disposition.

A growing body of research has demonstrated that experimentally induced short-term increases in a person's sense of felt-security using attachment SP, can act to generate favourable changes on a diverse range of participant clinical, social and behavioural variables (Admoni, 2006, as cited in Mikulincer & Shaver, 2007a; Beckes, Simpson, & Erickson, 2010; Carnelley & Rowe, 2007; Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007; Gillath et al., 2008; Mikulincer et al., 2001; Mikulincer, Hirschberger, Nachmias, & Gillath, 2001; Mikulincer & Shaver, 2001; Mikulincer, Shaver, Gillath, & Nitzberg, 2005; Mikulincer & Shaver, 2007b; Rowe et al., 2012; Selcuk, Zayas, Günaydýn, Hazan, & Kross, 2012; Wilkinson, Rowe, & Heath, 2013).

[6] The idea that mental representations are organised into large networks of cognitive nodes which excite or inhibit each other depending on if the representation is congruent or not with the presented stimuli. Associative networks have been hypothesised to underlie different attachment orientations, making different IWM self-maintaining. (Collins & Loftus, 1975).

SP has also been shown to be effective in reducing stressful intrusions after exposure to a traumatic film in an analogue sample (Arikan et al., 2012), and has been found to reduce AB to threatening-words in participants with war-time related experiences who report post-traumatic stress symptoms (Miterany, 2004 as cited in Mikulincer, Shaver, & Horesh, 2006).

Functional neuroimaging studies report post-SP reductions in negative-affect related neural activations associated with social rejection (Karremans, Heslenfeld, van Dillen, & Van Lange, 2011), physical pain (Coan, Schaefer, & Davidson, 2006; Coan, Kasle, Jackson, Schaefer, & Davidson, 2013; Eisenberger et al. 2011), and threatening word and face stimuli (Norman, Lawrence, Iles, Milad, & Karl, submitted).

Whilst theorised, the empirical success of SP in individuals with varying degrees of attachment style remains unclear. Some studies report SP to have beneficial effects on participants regardless of their attachment disposition (Carnelley & Rowe, 2007; Mikulincer et al., 2001; Mikulincer et al., 2005; Mikulincer & Shaver, 2007b), whilst others have reported that those who score highly on attachment avoidance (Mikulincer et al., 2006; Mikulincer & Shaver, 2007a) may show less response to SP.

Current Study

The current study seeks to be the first of its kind to extend current research findings to explore if the benefits of increasing felt-security through SP can be extended to a traumatised clinical sample to reduce AB and abnormal neural responses in the amygdala. This study uses an experimental design to investigate if SP in trauma-exposed individuals–who report high levels of current anxiety, acts to reduce their AB to threatening stimuli and reduce amygdala activation in response to threatening stimuli (angry and fearful emotional faces). The moderating impact of individual differences in global levels of attachment security on the effect of SP on AB and neural activations will also be investigated.

Hypothesis 1. Security-primed participants will show significantly less attentional bias toward threatening stimuli compared to non-security primed controls.

Hypothesis 2. Security-primed participants will show lower neural activations in the amygdala regions of interest when exposed to threatening emotional faces compared to non-security primed controls.

Hypothesis 3. Individual differences in scores on attachment insecurity measures are predicted to moderate the main effect of SP on AB and neural activation in the amygdala. Based on current findings, it is predicted that individuals high on attachment avoidance will be less susceptible to the effects of SP.

Method

Design

This study used a between-subjects experimental design investigating differences in AB and neural activation following attachment SP of trauma-exposed individuals. Participants were randomly assigned to experimental conditions (security-priming or neutral-priming control) using stratified randomisation, based on anxiety severity scores.

Participants

Inclusion/exclusion criteria. Participants were included if they had a history of trauma and current elevated levels of anxiety[7] to maximise recruitment inclusion. For informational purposes, participants were assessed for current symptoms of PTSD according to the DSM-IV criteria.

[7] Above the 'severe' range on the anxiety screening tool (refer to measures and materials section)

Participants currently taking anxiolytic medication or who had experienced a recent change in antidepressant medication were excluded from the study as this may have affected neural measures.

For safety reasons, participants were excluded if they had any fMRI contraindications (e.g. metal implants) in accordance with the MRI scanning centre safety policy. Participants with a history of neurological illness or injury were excluded from taking part.

Recruitment. Participants were recruited from services within two secondary care mental health trusts, one primary care trust, one emergency service trust, the local community and from the University of Exeter student and staff community. Recruitment was based on an opt-in system, where participants contacted the researcher after seeing poster/leaflet/media articles, or being informed of the study by members of their care-team.

A total of 107 participants were telephone screened to take part in the study. Of these, 27 participants did not meet the MRI safety criteria, 18 withdrew or did not attend the testing session and 21 did not meet the study inclusion criteria[8]. A total of 41 participants took part in the scanning task. Of these, one participant opted out on the testing day, and one participant was excluded due to the head-coil not being able to accommodate their head size. Of the final 39 participants included in the study, four participants were excluded due to technical problems with scanner and stimulus presentation software, and one participant was excluded due to >50% deviant trials on the dot-probe task. A final sample size of 34 right-handed participants was included in the analyses (8 males, 26 females, $M_{age} = 38.91$ (*SD*, 12.66), age range: 20-59 years). All participants reported a history of trauma and high current levels of

[8] 6: non-right handed; 6: no history of trauma or low levels of anxiety; 5: reported previous severe head injury/neurological illness; 4: current use of anxiolytic or analgesic medication/recent change in medication.

anxiety; >91% of the sample met the DSM-IV diagnostic criteria for sub-syndromal[9] PTSD (14.7%) or full PTSD (76.5%). Refer to the participant flow diagram in Appendix 3.

Measures and Materials (see expanded method section, Appendix 2, for more details)

Measures.

Refer to Table 1 which outlines the measures used in the study.

[9] Indicated by self-reported symptomatic intrusion symptoms with the presence of either symptomatic hyperarousal or avoidance symptoms concordant with DSM-IV (American Psychiatric Association, 2000).

Table 1.

Screening, Symptom, Individual Difference, Experimental State and Manipulation Check Measures Used

Measure type	Measure name and description
Screening measures	*Screening interview:* A tool constructed for telephone screening for inclusion/exclusion criteria, and collection of demographic and trauma information. *Depression, Anxiety and Stress Scales* (DASS-21*:* Henry & Crawford, 2005): Used to identify elevated levels of anxiety. A 7-item self-report scale to assess symptoms of anxiety within the past week. Four-point Likert-type scales are used (0 = *did not apply to me at all* to 3 = *applied to me very much or most of the time*). Scores above ≥15 indicate severe anxiety levels. Published Cronbach's α=.82-.90; Current study α= .81-.89. *Primary Care PTSD Screen* (PC-PTSD: Prins et al., 2003): A 4-item measure designed to screen for current PTSD symptomology in the last month. *Edinburgh Handedness Inventory* (EHI: Oldfield, 1971): A 10-item self-report measure used to establish hand dominance. Published Cronbach's α=.86; Current study α= .80
Symptom measures	*PTSD Checklist-Civilian Version* (PCL-C: Weathers, Huska, & Keane, 1991): A 17-item self-report measure of current PTSD symptom severity based on DSM-IV diagnostic criteria (American Psychiatric Association, 2000). Five-point Likert scale response scales are used. The PCL-C is highly correlated (r = .93) with the Clinician Administered PTSD Scale (Blake et al., 1990). Published Cronbach's α=.94-.97; Current study α= .79-.87.
Individual differences measures	*Early Trauma Inventory Self-Report Short Form* (ETISR-SF: Bremner, Bolus, & Mayer, 2007): Screens for traumatic experiences before the age of eighteen in four domains: general traumas, physical punishment, emotional abuse and sexual events. 'Yes' or 'no' responses are given. Published Cronbach's α=.70-.87; Current study α= .79-.88.

	*Relationship Structures Questionnaire (*RSQ: Fraley, Niedenthal, Marks, Brumbaugh, & Vicary, 2006): Abbreviated version of the Experiences in Close Relationships-Revised (ECR-R: Fraley, Waller, & Brennan, 2000). The measure consists of 40 questions which provide a measure of 'global attachment anxiety' and 'global attachment avoidance'. Participants respond on a 7-point Likert scale (1 = "*strongly disagree*" to 7 = *strongly agree*). Low scores on both dimensions reflect a secure global attachment style. Published Cronbach's α= 0.89: Fraley et al., (2000); Current study α= 0.82-0.87.
Experimental state measures/ manipulation checks.	*Self-Assessment Manikin* (SAM: Bradley & Lang, 1994): A non-verbal pictorial assessment tool that measures feelings of state happiness (SAM item 1: lower scores indicate greater state happiness), emotional arousal (SAM item 2: lower scores indicate higher emotional arousal) and control (SAM item 3: lower scores indicate less control). *State Adult Attachment Measure* (SAAM: Gillath, Hart, Noftle, & Stockdale, 2009): State-like variations in working models of attachment was measured using items adapted from the SAAM: "The idea of being emotionally close to someone makes me nervous" (item one), "I really need to feel loved" (item two), and "I desperately need to feel loved and safe" (item three). Items which were measured using a five point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). Lower scores indicated higher state attachment felt-security.

Experimental tasks.

E-Prime software (Psychology Software Tools, Inc.; www.psnet.com/eprime) was used to deliver and record responses on the three experimental paradigms administered. Stimuli were presented during scanning using an Epson EMP-74 digital projector system projected

onto a display at the foot of the scanner, which was viewed via an angled mirror attached to the head coil. Responses for all tasks were made by participants via two fibre-optic response button-boxes, one in each hand.

Security-priming. The attachment SP task was made up of visual stimuli as indicated by previous successful SP studies (Bartels & Zeki, 2000; Mikulincer, Shaver, & Rom, 2011), and aimed to temporarily increase participants' sense of felt-security by presenting 60 colour images (taken from the International Affective Picture System (IAPS: Lang, Bradley, & Cuthbert, 2008), which depicted people engaging in caregiving behaviours and enjoying close attachment relationships. The control neutral-priming task utilised images of people completing everyday mundane tasks instead of attachment-oriented images. All priming stimuli were validated in a pilot study[10] prior to commencing the current study. Each image was presented to participants on a screen for 2.5s, with an inter-stimulus interval of 0.5s. Six blocks of 10 images were presented, and each block was interleaved with a 10s rest period showing a fixation cross in the centre of the display. Photographs were presented on the left or right side of the display, and participants were instructed to press a button to indicate the position of the image on the screen as quickly and accurately as possible. Total task length was 6.5 minutes.

Attentional bias.

Dot-probe task. The validated dot-probe paradigm (El-Khoury-Malhame et al., 2011b; Mogg & Bradley, 1999) provides a measure of AB. It involves the simultaneous presentation of word-pairs. On each trial, one word was presented above the midpoint of the screen and the

[10] A pilot study of 13 participants assessed the photographs on six point Likert scales for the extent to which they made them feel loved, safe, happy, calm and comforted. For the attachment stimuli, the mean ratings were 4.39 (SD= 1.17), 4.25 (SD= 1.01), 4.63 (SD= 0.99), 4.16 (SD= 0.95) and 4.29 (SD=1.04), respectively. Lower ratings on the loved (M= 2.66, SD=1.21), safe (M=2.88, SD=1.24), happy (M=2.86, SD=1.33), calm (M=2.80, SD=1.38) and comforted (M=2.73, SD=1.24) measures were provided for the control stimuli.

other of the pair below this midpoint. After the offset of each word-pairing, an asterisk probe replaced one of the two words, and participants were instructed to indicate which of the words had been replaced by the probe as quickly and accurately as possible.

Each trial consisted of three components on a black screen background; a fixation cross displayed for 500ms in the centre of the screen, followed by the presentation of word-pair stimuli for 500ms, followed by a probe display. Three trial types were utilised. In congruent trials, participants must respond to a probe which replaces a threat word on the screen in a threat-neutral word-pair. In incongruent trials, a neutral word is replaced by the probe in a threat-neutral word-pair, and in neutral trials the probe replaces one of the words in a neutral-neutral word-pair. AB is calculated by subtracting participant's average response times (ms) on incongruent trials from their average response times on congruent trials. The task consisted of 128 trials (32 congruent trials, 32 incongruent trials, 64 neutral trials), and threat word position, probe position, and trial-type were counterbalanced across trials. Total task length was 6 minutes.

General threat-related words and neutral words were utilised, taken from the Affective Norms for English Words standardized list (ANEW: Bradley & Lang, 1999). The task utilised threat words which were semantically linked to danger or trauma (average valence = 2.15) matched on word frequency (Kucera & Francis, 1967) and length with neutral words (average valence = 5.23) to make threat-neutral word pairings.

Neural activation.

Matching task. The matching task closely reflected a validated face-matching paradigm proven to elicit measurable amygdala activation in fMRI research (Hariri, Bookheimer, & Mazziotta, 2000). This task utilised 60 colour photographs of fearful or angry faces (15 mild anger, 15 high anger, 15 mild fear, and 15 high fear) which were drawn from the NimStim Set

of Facial Expressions (Tottenham et al., 2009). The set of facial stimuli featured 20 different actors (10 female and 10 male), and each face was used three times.

On each trial, participants were presented with sets of either three visually displayed fearful or angry emotional faces, or three shapes (baseline control sensorimotor condition), and their task was to match one of the two faces or shapes presented at the bottom of the screen with the target face or shape at the top of the screen using the response-box buttons. Face matching was performed according to shared facial emotional expression, whilst shape matching (ellipses or circles) was performed according to shape and spatial orientation. Each trio of stimuli was presented for 4s, and consecutive trials were separated by an inter-stimulus interval of 0.5s. In total, six-blocks of face matching conditions were completed with each block consisting of 10 trials. Interspersed between face matching conditions were six-blocks of the shape matching sensorimotor control condition, with a two second interval between blocks, during which reminder instructional prompts were presented: “match faces!” or “match shapes!”. Total task length was 9.5 minutes.

fMRI Data Acquisition

Activation during the face-matching task was measured using a 1.5-T Philips Gyroscan MRI scanner fitted with a quadrature head coil. A T 2 *-weighted echoplanar imaging (EPI) sequence was utilised, with a TR of 3.0 seconds and 190 volumes were acquired for each participant (scan duration = 9 minutes 30 seconds, TE=45ms, voxel size = 3x3x3mm, number of slices = 39, FOV=240mm, flip angle=90 degrees). For each participant, functional data were overlaid on a high- resolution T1-weighted SENSE anatomical image for registration into standard space and functional localisation (3D T1 FFE, TR=25ms, TE= 4.5ms, voxel size = 0.9x0.9x1.6mm, number of slices = 160, FOV = 230mm, flip angle = 30 degrees).

Procedure

Ethical approval for this study was granted by the University of Exeter, School of Psychology Ethics Committee, and the National Health Service National Research Ethics Service. Local trust approval was also gained from all trusts recruited in, and all materials were approved by service-users in a focus group.

Individuals initially took part in a screening telephone interview where they were asked to divulge brief details about the nature of their traumatic experience, and were administered the PC-PTSD, DASS-21 and the EHI. If eligible, participants were recruited into the study and completed the RSQ before the day of scanning.

The experimental session took part at the Peninsula Magnetic Resonance Imaging Research Centre. On the day of scanning, after giving informed consent, participants were given verbal and written instructions of the experimental tasks that they would be doing in the MRI scanner, before being placed in the scanner.

After an initial structural scan sequence, participants were asked to provide state measure ratings on the SAAM and SAM. Participants then completed the in-scanner tasks, and were reminded of all task instructions on the screen and instructed to "*press any button to begin*". Participants first took part in their respective condition's priming task, before providing post-priming state measure ratings. Participants then completed the dot-probe task. All participants then took part in an additional two blocks of their respective priming condition, which served to refresh secure-attachment representations, which may have weakened during the first task. Participants then completed the matching task. After the scanning tasks were complete, participants returned to the waiting area and were asked to complete the PCL-C and ETISF-R, and were then de-briefed.

Data Preparation and Statistical Analysis Strategy

Behavioural data preparation. Preparation and analysis of demographic, questionnaire and behavioural data was conducted using SPSS for Windows, version 18.0. Independent sample t-tests, Mann-Whitney tests on data which violated parametric assumptions, and chi-square analyses were used to investigate differences between groups on demographic and other non-fMRI variables at baseline.

All questionnaire and behavioural measures were checked for outliers using the SPSS explore function, and inspection of box plots. They comprised less than 5% of the data. In order to retain all study participants, outlier scores were winsorized based on the interquartile range of each variable (Tukey's hinges: Tukey, 1977); i.e. transformed to set data above the 95th percentile to the 95th percentile (Tabachnick & Fidell, 2001).

The assumptions of parametric testing were checked as follows: The normality of the distribution was checked by applying the Shapiro-Wilk test of normality and by plotting histograms for each group's scores on each dependent variable and questionnaire data. Values of skewness and kurtosis were also checked and converted to *z*-scores[11] to check for significant skewness or kurtosis values[12]. All *z*-scores indicated non-significant skewness and levels of kurtosis ($p>.05$). Homogeneity of variance was checked using the Levene test for equality of variances. All tests performed upon data were two-tailed with statistical significance taken to be indicated by $p<.05$.

Behavioural data analysis. Behavioural analysis was conducted on the dot-probe task and state measures. Deviant trials were excluded, determined using standard criteria (Mogg & Bradley, 1999; Woolrich, Ripley, Brady, & Smith, 2001), where reaction time (RT) >800ms or

[11] By subtracting skewness/kurtosis value from the mean of the normal distribution of skewness/kurtosis (zero) and dividing by the standard error of the skewness/kurtosis (Field, 2009).

[12] *z*-scores greater than the value of 1.96 indicates a significant value of skewness or kurtosis and indicates significantly non-distributed data which is not suitable for parametric statistics (Field, 2009).

<200ms, or incorrect responses were given. This constituted <3% for the control condition and <3.5% for the SP condition. A 2x2 mixed-design ANOVA was performed on the dot-probe task data with trial-type mean RT (congruent versus incongruent) as the within subjects factor and priming group (security-priming versus neutral priming) as the between subjects factor. As no interactions were found, no post-hoc analyses were conducted on this data.

In order to test whether global attachment anxiety and attachment avoidance moderated the effect of SP on AB, a linear regression analysis (Aiken & West, 1991) using the enter method was conducted in SPSS. Interaction terms were calculated (attanxXprim; attavoidXprim) and moderating and dependent variables were centred. Each regression model was checked using SPSS for normal distribution of residuals by inspection of scatterplots, multicollinearity by checking tolerance levels, and autocorrelation using Durbin-Watson tests.

For manipulation checks, a 2x2 mixed-design ANOVA was performed on felt-security and SAM measures with time point (pre-priming versus post-priming) as the within subjects factor and priming group (attachment versus control) as the between subjects factor. Post hoc comparisons were then conducted on any significant interactions found using bonferroni-corrected repeated measures ANOVAs for pre and post priming differences, and bonferroni-corrected independent samples t-tests for between group-differences at pre and post-priming time points.

fMRI data preparation. Data pre-processing and statistical analysis were conducted using FEAT (fMRI Expert Analysis Tool) Version 5.98, part of FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl). For each participant, the following standard pre-processing protocols were applied: Motion correction (Jenkinson, Bannister, Brady, & Smith, 2002); Non-brain removal (Smith, 2002); Spatial smoothing using a Gaussian kernel (5mm full-width-half-maximum); Grand-mean intensity normalisation, and high pass temporal filtering (Gaussian-weighted least-squares straight line fitting, with sigma=100.0s). Registration of functional data

to high resolution T1 structural images and co-registration to standard space (Montreal Neurological Institute 152 template) was conducted using FLIRT (Jenkinson et al., 2002; Jenkinson & Smith, 2001).

Each single-subject pre-processed data set was analysed using a general linear model approach with local autocorrelation correction (Woolrich et al., 2001). The onset of the trial blocks of emotional faces was modelled as a box-car regressor, with the shape-matching blocks modelled implicitly as a baseline. Individual contrast maps for the face-matching condition versus shape-matching condition were generated for each participant, ready to be entered into a higher level between-group analysis.

Higher level between-group analysis. Concordant with the hypothesis that SP would reduce threat-related neural activation, the higher level analysis compared group activation between experimental conditions. Higher level between-group analyses were conducted using the mixed-effects model FLAME 1 (FMRIB's Local Analysis of Mixed Effects), in which participants are treated as a random effect (Beckmann, Jenkinson, & Smith, 2003; Woolrich et al., 2004). FSL's automatic outlier detection algorithm was used for all higher level contrasts (Woolrich, 2008). Corrections for multiple comparisons were conducted at the cluster level using Gaussian Random field theory ($z > 2.3$, $p < .05$, corrected: Worsley, 2001).

Region of interest data preparation. To further test the hypothesis regarding amygdala activation, four anatomically-defined regions of interest (ROIs) were analysed. ROIs of the ventral and dorsal amygdala from the right and left hemisphere were created using WFU-Pickatlas (http://www.fmri.wfubmc.edu/download.htm). Separate dorsal and ventral ROIs were defined due to the functionally heterogeneous nature of the subnuclei within the amygdala. This was concordant with analyses conducted by previous studies which have utilised the matching task design (Carré, Fisher, Manuck, & Hariri, 2012).

Region of interest statistical analyses. For each ROI, mean % BOLD signal change was obtained from individuals' lower level contrast of parameter estimates (COPE) (faces >shapes). This allowed for independent sample t-tests to be conducted between priming conditions for % BOLD signal changes between face and baseline shape trials in the ROIs.

In order to test whether global attachment anxiety and attachment avoidance moderated the effect of SP on amygdala ROI activation during the emotional faces matching task, a linear regression analysis (Aiken & West, 1991) using the enter method was conducted in SPSS. Interaction terms were calculated (attanxXprim; attavoidXprim) and moderating and dependent variables were centred. Each regression model was checked using SPSS for normal distribution of residuals by inspection of scatterplots, multicollinearity by checking tolerance levels, and autocorrelation using Durbin-Watson tests.

Results

Sample Characteristics and Scores on Baseline Variables

Descriptive statistics were calculated for the final sample for continuous (refer to Table 2) and nominal (refer to Table 3) demographic variables, questionnaire data and baseline variables. The *n* values reported in Table 2 differ for baseline state measures as data was lost for three participants due to an e-prime script technical error.

Table 2.

Mean Scores on Baseline Continuous Variables by Sample, Condition, and Group Comparisons

Variable	*N*	Mean	*SD*	Neutral priming control group *n*=18 *M* (*SD*)	Security priming group *n*=16 *M* (*SD*)	Test statistic for difference between groups (*t* or *U*)	*df*	*p*
		N=34						
Age	34	38.91	12.66	40.89 (10.77)	36.69 (14.54)	0.97	27.44	.35
DASS anxiety total score	34	24.18	7.19	23.67 (5.95)	24.75 (8.54)	-0.43	32	.67
RSQ global attachment anxiety score	34	2.88	1.31	2.42 (1.19)	3.40 (1.27)	-2.30	32	.03*
RSQ global attachment avoidance score	34	3.70	1.12	3.44 (1.10)	3.99 (1.10)	-1.47	32	.15
PCL-C total score	34	54.47	14.23	51.17 (12.59)	58.19 (15.42)	-1.46	32	.15
ETISF-SR total score	34	10.00	4.96	9.50 (4.77)	10.56 (5.28)	-0.62	32	.54
Felt Security - Item 1	31	2.77	1.13	2.71 (1.31) *n*=17 MR =16.44	2.96 (0.93) *n*=14 MR=17.59	45.00	n_1=17 n_2=14	.72

Felt Security - Item 2	31	3.64	1.32	3.71 (1.26) *n*=17 MR=17.41	3.36 (1.39) *n*=14 MR=16.56	129.00	n_1=17 n_2=14	.79
Felt Security - Item 3	31	3.21	1.50	3.30 (1.45) *n*=17 MR=17.41	2.93 (1.59) *n*=14 MR=16.56	129.00	n_1=17 n_2=14	.80
State unhappiness	31	2.82	0.98	2.53 (0.62) *n*=17 MR=14.24	3.21 (1.12) *n*=14 MR=19.94	183.00	n_1=17 n_2=14	.07
State emotional arousal	31	3.09	1.16	3.29 (1.16) *n*=17 MR=18.38	2.71 (1.14) *n*=14 MR=15.53	112.50	n_1=17 n_2=14	.38
State control	31	2.91	1.10	2.82 (0.88) *n*=17 MR=16.00	3.00 (1.36) *n*=14 MR=18.06	153.00	n_1=17 n_2=14	.53

Note. MR = Mean Rank
* $p < .05$
Felt-security: Items scored on five point scale (1=*strongly disagree*, 5=*strongly agree*).
Lower scores indicate higher state attachment felt-security.
Felt-security item one: "The idea of being emotionally close to someone makes me nervous".
Felt-security item two: "I really need to feel loved".
Felt-security item three: "I desperately need to feel loved and safe".
Self-Assessment Manikin items: Items scored on a pictorial scale, scored 1-5.
State unhappiness: Lower scores indicate greater state happiness.
State emotional arousal: Lower scores indicate higher emotional arousal.
State control: Lower scores indicate less control.

Table 3.

Proportions of Demographic Variables by Sample, Condition, and Group Comparisons

Variable	Sample *N*=34	Neutral priming control group *n*=18	Security priming group *n*=16	Test statistic for difference between groups (χ^2)	*df*	*p*
Sex	Male=8 (23.5%) Female=26 (76.5%)	Male=6 (33.3%) Female=12 (66.7%)	Male=2 (12.5%) Female=14 (87.5%)	0.43	1	.15
Marital status	Single=25 (73.5%) Married=9 (26.5%)	Single=12 (66.7%) Married=6 (33.3%)	Single=13 (81.3%) Married=3 (18.8%)	0.93	1	.29
Occupation	Employed=19 (55.9%) Unemployed=4 (11.8%) Student=11 (32.4%)	Employed=10 (55.6%) Unemployed=2 (11.1%) Student=6 (33.3%)	Employed=9 (56.3%) Unemployed=2 (12.5%) Student=5 (31.3%)	0.03	2	.99
Education	Standard=21 (61.8%) Higher=13 (38.2%)	Standard=9 (50.0%) Higher=9 (50.0%)	Standard=12 (75.0%) Higher=4 (25.0%)	2.24	1	.13
Medication	No=24 (70.6%) Yes=10 (29.4%)	No=14 (77.8%) Yes=4 (22.2%)	No=10 (62.5%) Yes=6 (37.5%)	0.95	1	.28

PTSD caseness	NoPTSD=3 (8.8%) SubPTSD=5 (14.7%) Full PTSD=26 (76.5%)	No PTSD=2 (11.1%) SubPTSD=4 (22.2%) Full PTSD=12 (66.7%)	No PTSD=1 (6.3%) SubPTSD=1 (6.3%) Full PTSD=14 (87.5%)	2.18	2	.34
Trauma type (Type I or II)	Type I=17 (50%) Type II=17 (50%)	Type I=8 (44.4%) Type II=10 (55.6%)	Type I=9 (56.3%) Type II=7 (43.8%)	0.47	1	.37
Nature of trauma (accidental or interpersonal)	Accidental=4 (11.8%) Interpersonal=30 (88.2%)	Accidental=2 (11.1%) Interpersonal=16 (88.9%)	Accidental=2 (12.5%) Interpersonal=14 (87.5%)	0.02	1	.65
Presence of early general trauma (ETISF-SR)	Yes=31 (91.2%) No=3 (8.8%)	Yes=16 (88.9%) No=2 (11.1%)	Yes=15 (93.8%) No=1 (6.3%)	0.25	1	.55
Presence of early physical punishment trauma (ETISF-SR)	Yes=27 (79.4%) No=7 (20.6%)	Yes=16 (88.9%) No=2 (11.1%)	Yes=11 (68.8%) No=5 (31.2%)	2.10	1	.15
Presence of early emotional abuse trauma (ETISF-SR)	Yes=30 (88.2%) No=4 (11.8%)	Yes=15 (83.3%) No=3 (16.7%)	Yes=15 (93.8%) No=1 (6.3%)	0.89	1	.35
Presence of early sexual event trauma (ETISF-SR)	Yes=19 (55.9%) No=15 (44.1%)	Yes=9 (50.0%) No=9 (50.0%)	Yes=10 (62.5%) No=6 (37.5%)	0.54	1	.35

Note. *Education:* Standard = ≤ A-levels/GNVQ; Higher= ≥ Degree.
Medication: Anti-depressant medication (not recently changed)

PTSD caseness: Determined by self-report PCL-C: NoPTSD= no diagnostically significant symptoms; SubPTSD = sub-syndromal PTSD[13]; Full PTSD: diagnostically significant PTSD symptoms.
Trauma type: Type I trauma is considered to be a single traumatic event such as a fire, or single rape episode. Type II is considered to be a repeated, prolonged trauma such as extensive child abuse (Terr, 1991).
Nature of trauma: Accidental trauma[14] or interpersonal trauma[15]

As can be seen in Tables 2 and 3, there were no significant differences between the two groups on all demographic variables, questionnaire data, and baseline state variables, with the exception of higher levels of global attachment anxiety existing in the SP condition (p=.03) compared to the control group.

Manipulation Check

State measures were collected for 31 participants pre and post priming (secure: n= 14; neutral: n=17). State measures were analysed for significant change as a function of security-priming (refer to Table 4). No priming condition by state interaction existed for state felt-security items on the SAAM.

A significant priming by state interaction was observed for state happiness, however Bonferroni-corrected (p<.02) post hoc comparisons revealed no significant differences between pre and post priming state happiness, in the neutral (p=.22) or secure condition (p=.14). Bonferroni-corrected (p<.02) post hoc comparisons also showed no between-group differences at pre (p=.04) and post (p=.81) priming time points.

A significant priming by state interaction was observed for state emotional arousal, however post hoc comparisons revealed no significant differences in pre and post priming state

[13] Indicated by self-reported symptomatic intrusion symptoms, with symptomatic hyperarousal *or* avoidance symptoms, concordant with DSM-IV (American Psychiatric Association, 2000).

[14] Considered to be an experience brought about through no purposeful intent.

[15] "Family and intimate partner violence…violence between individuals who are unrelated…child abuse, violence, random acts of violence, rape, or sexual assault by strangers, and violence in institutional settings...sudden bereavement" (World Health Organization, 2002, p. 14).

emotional arousal in the neutral (p=.06) or secure conditions (p=.34). Bonferroni-corrected (p<.02) post hoc comparisons also showed no between-group differences at pre (p=.17) and post (p=.98) priming time points.

These analyses indicated that SP was not successful in increasing the levels of self-reported felt-security in the SP condition, or creating favourable changes on state measures.

Table 4.

State Measure Means, SDs, Group Comparisons and Effect Sizes

State measure (1-5)	Security-Priming *n*=14		Neutral *n*=17		Within-subjects main effect of time				Priming group by time interaction				Between-subjects main effect of priming on state measure			
	PRE	POST	PRE	POST	Test statistic (*F*)	*df*	*p*	η_p^2	Test statistic (*F*)	*df*	*p*	η_p^2	Test statistic (*F*)	*df*	*p*	η_p^2
Felt security (item 1)	2.96 (0.93)	2.50 (1.29)	2.71 (1.31)	2.56 (1.17)	1.59	1, 29	.217	.052	0.429	1, 29	.517	.015	0.078	1, 29	.782	.003
Felt security (item 2)	3.36 (1.39)	2.57 (1.45)	3.71 (1.26)	3.24 (1.44)	9.603	1, 29	.004**	.249	0.604	1, 29	.443	.020	1.228	1, 29	.277	.041
Felt security (item 3)	2.93 (1.59)	2.43 (1.22)	3.30 (1.45)	3.06 (1.39)	2.968	1, 29	.096	.093	0.385	1, 29	.540	.013	1.143	1, 29	.294	.038
State unhappiness	3.21 (1.12)	2.86 (1.23)	2.53 (0.62)	2.76 (0.83)	0.181	1, 29	.674	.006	4.276	1, 29	.048*	.129	1.521	1, 29	.227	.050
State arousal	2.71 (1.14)	2.93 (1.21)	3.29 (1.16)	2.94 (1.20)	0.264	1, 29	.612	.009	4.411	1, 29	.045*	.132	0.542	1, 29	.468	.018
State control	3.00 (1.36)	3.14 (1.35)	2.82 (0.88)	2.88 (0.93)	0.261	1, 29	.613	.009	0.045	1, 29	.833	.002	0.375	1, 29	.545	.013

Note.
Felt security: Items scored on five point scale (1 = *strongly disagree*, 5 = *strongly agree*). Lower scores indicate higher state attachment felt security.
Felt security item 1: "The idea of being emotionally close to someone makes me nervous".
Felt security item 2: "I really need to feel loved".
Felt security item 3: "I desperately need to feel loved and safe".
Self-Assessment Manikin items: Items scored on a pictorial scale, scored 1-5.
State unhappiness: Lower scores indicate greater state happiness.
State emotional arousal: Lower scores indicate higher emotional arousal.
State control: Lower scores indicate less control.
p < .05. **p < .01.

Main Findings

Hypothesis 1. Hypothesis 1 predicted that security-primed participants would show a significantly lower AB toward threatening stimuli compared to non-security primed controls.

Attentional bias measure: dot-probe task. At whole sample level (*N*=34), a significant within-subjects main effect existed, where participants responded more quickly to congruent trial-types (*M*=544.36ms, *SD*=96.12) compared to incongruent trial-types (*M*=553.75ms, *SD*=98.30), showing a significant AB towards threatening stimuli ($F(1,32)=8.738$, $p=.006$, $d = 0.44$, $\eta_p^2 = .214$). However, no priming group by trial-type RT interaction existed ($F(1,32)=1.222$, $p=.277$, $\eta_p^2 = .037$). No between-group main effect existed ($F(1,32)=1.333$, $p=.257$, $\eta_p^2 = .040$).

It was therefore found that there was no significant difference in AB towards threatening words between groups following security-priming, and the null hypothesis was retained.

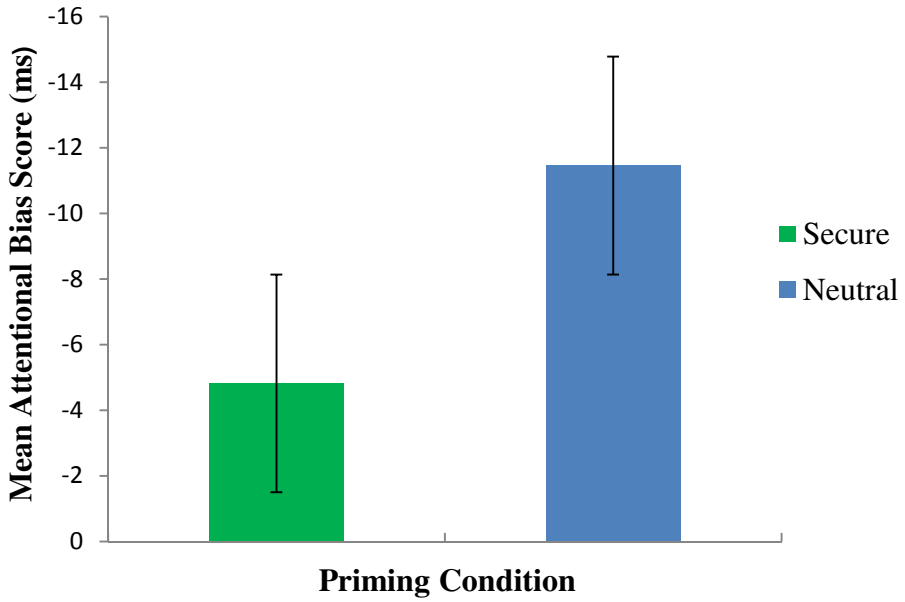

Figure 1. Mean and standard error of attentional bias scores (ms) in each condition.

Hypothesis 2. Hypothesis 2 predicted that security-primed participants would show lower neural activations as indicated by mean % BOLD signal changes in the amygdala ROI when exposed to threatening facial stimuli compared to non-security primed controls.

Whole-brain comparison. At the whole brain level (corrected for multiple comparisons), there were no significant differences in activation between the attachment SP versus control neutral-priming conditions. Using a less conservative correction, set above the whole-brain corrected statistical cluster threshold[16], greater activations were shown by the attachment security-priming group in the right dorsal amygdala area (refer to Figure 2).

Regions of interest. In the defined ROIs, opposite to the hypothesis, greater activation was found in the right dorsal amygdala ROI in the SP condition (M=0.18%, SD=0.25) compared with the control group (M=-0.07%, SD=0.28) as assessed by mean % BOLD signal change (refer to Figure 3). This difference was found to be significant (t(32)=-2.674, p=.012, two-tailed, 95% CI [-0.43, -0.06], d = 0.92). Non-significant results were found for activation between conditions for the left dorsal amygdala (t(21.15)=-1.208, p=.240, two-tailed, 95% CI [-0.34, 0.08], d = 0.43), right ventral amygdala (t(32)=-0.548, p=.587, two-tailed, 95% CI [-0.13, 0.23], d = 0.19), or the left ventral amygdala (t(32)=-0.071, p=.944, two-tailed, CI 95% [-0.23, 0.25], d = 0.02).

Findings indicated significant differences in neural activation between priming conditions in the opposite direction dictated by the hypothesis, the null hypothesis was therefore rejected.

[16] Whole-brain corrected statistical threshold: z> 2.3, p<.05, corrected (Worsley, 2001).

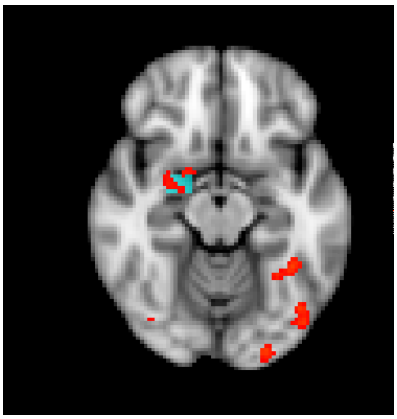

Figure 2. Shows the right dorsal amygdala region showing between-group differences in BOLD response to threatening facial stimuli (where security-priming condition>control condition). The blue region indicates the anatomical ROI (extracted BOLD data are shown below in Figure 3), and the red regions indicate sub-threshold between-group differences at the whole-brain level (uncorrected at the cluster level).

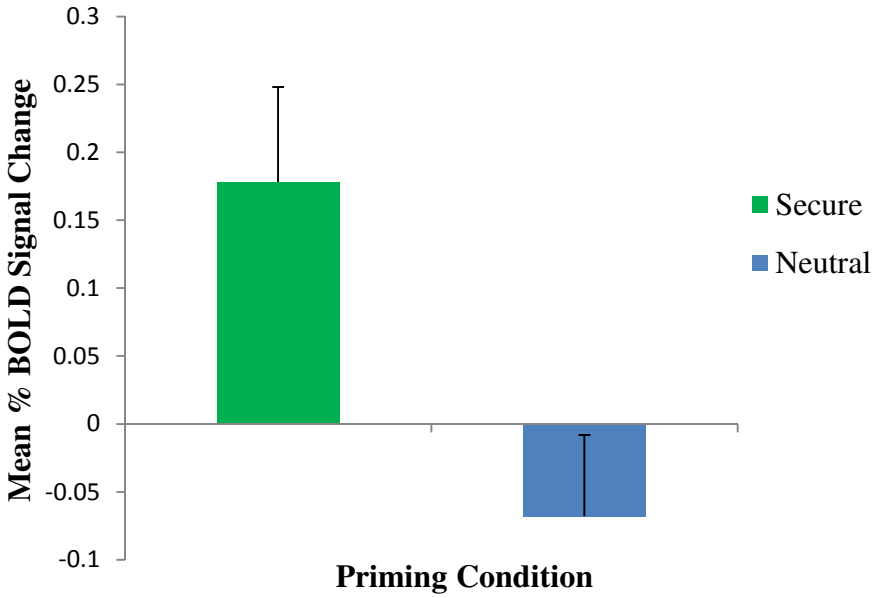

Figure 3. Mean % BOLD signal change and standard error in the right dorsal amygdala ROI in each priming condition in response to threatening emotional facial stimuli.

Hypothesis 3. Hypothesis 3 predicted that individual differences on attachment dimensions would moderate the association between SP, and AB and neural activation in the ROI.

Moderation analyses. Linear regression analysis showed no moderation effect of global attachment anxiety or attachment avoidance on the relationship between SP and AB.

Linear regression analysis also showed no moderation effect of global attachment anxiety or attachment avoidance on the relationship between attachment priming and activation in the right dorsal amygdala ROI.

No significant regression models emerged, and the null hypothesis was retained (refer to Table 5). One significant zero-order correlation existed between priming condition and mean % BOLD change in right dorsal amygdala activation.

Table 5.

Linear Regression Models Examining the Moderating Influence of Attachment Anxiety and Attachment Avoidance on the Effect of Security-Priming on Attentional Bias and Change in Neural Activation in the Right Dorsal Amygdala in Response to Threatening Faces

Independent/ moderator variables	Attentional bias						Right dorsal amygdala activation					
	Attachment anxiety as moderator			Attachment avoidance as moderator			Attachment anxiety as moderator			Attachment avoidance as moderator		
	β	*t*	*p*	β	*t*	*p*	β	*t*	*p*	β	*t*	*p*
Priming condition	.31	1.66	.11	.30	1.76	.09	.38	2.18	.04	.40	2.38	.02
Attachment anxiety	-.17	-0.65	.52	-	-	-	.01	.04	.97	-	-	-
Attachment avoidance	-	-	-	-.21	-0.88	.39	-	-	-	.01	0.02	.99
Priming condition X attachment anxiety	-.10	-0.40	.69	-	-	-	.16	.66	.52	-	-	-
Priming condition X attachment avoidance	-	-	-	-.18	-0.77	.45	-	-	-	.15	0.67	.51
R^2	.11			.17			.21			.21		
F (*df*)	1.17 (3, 30)			2.02 (3, 30)			2.62 (3, 30)			2.59 (3, 30)		
p	.34			.13			.07			.07		
ES (F^2)	.12			.20			.26			.26		

Note. $N = 34$; ES = effect size

Consideration of Effect Size

For hypothesis 1, a medium effect size (Cohen, 1988) existed (d = 0.44) for the effect of SP on AB.

For hypothesis 2, neural activation to emotional faces between priming conditions yielded effect sizes ranging from small to large: d=0.43, for the left dorsal amygdala ROI; d=0.92, for the right dorsal amygdala; d=0.02, for the left ventral amygdala; d=0.19, for the right ventral amygdala.

For hypothesis 3, the moderating effect of attachment anxiety and attachment avoidance on the relationship between attachment SP and AB, small to medium effect sizes of F^2=0.12 and F^2=0.20 were found, respectively.

For the moderating effect of attachment anxiety and attachment avoidance on the relationship between attachment SP and mean % BOLD signal changes in the right dorsal amygdala ROI, medium effect sizes of F^2=0.262 and F^2=0.259 were found, respectively.

Where findings showed changes in the hypothesized direction of significance for SP on AB, a post-hoc sample-size calculation was conducted using G*Power (based on an independent means t-test) using the effect size observed in this study. This revealed a total sample of N=166 would achieve a power of 80%, whereas this study only recruited N=34.

Discussion

The aim of this study was to investigate if secure attachment priming acts to decrease attentional bias to verbal threat as measured by the dot-probe paradigm, and to decrease neural activation of the amygdala when presented with threatening social cues in the form of angry and frightened faces, in a trauma-exposed sample. The study also examined if individual differences in trait attachment security moderate the association between SP and AB and neural response.

This is the first known study to examine the effect of SP on both the AB and neural regions in a trauma-exposed clinical sample. Whilst, in the sample as a whole, a significant AB towards threatening stimuli existed, consistent with current research (Constans et al., 2004; El-Khoury-Malhame et al., 2011b), this study found that security-priming individuals did not act to significantly reduce AB or neural activation in the amygdala regions known to be heightened in traumatised individuals. No moderation effect of global attachment style existed on SP and changes in AB or neural activation. Unexpectedly, significantly increased amygdala activation was observed in the SP condition on the matching paradigm in response to emotionally threatening face stimuli.

Contrary to the findings of the one study that exists which examines SP on AB in a trauma-exposed sample (Miterany, 2004 as cited in Mikulincer et al., 2006), these findings suggest that SP does not facilitate significant favourable change in AB. However, some important differences do exist between the studies. The Miterany study employed a non-clinical uniform sample of undergraduates with wartime experiences who reported post-traumatic stress symptoms. The sample used in the current study is markedly different from the Miterany study in terms of trauma experiences represented. The overall sample consisted of over 85% of trauma types of an interpersonal nature, with 50% of the sample experiencing a chronic type II trauma, 55% of the whole sample having experienced an early sexual-event trauma, almost 80% having experienced an early physical punishment trauma, and 88% of the whole sample reporting experiencing emotional abuse in childhood. The current study sample, also scored much lower on measures of trait attachment security compared to scores in the general population (Fraley et al., 2006). The sample employed therefore contains a majority representation of interpersonal traumatic experiences.

The mechanisms through which attachment SP are theorised to work involve making a secure attachment relationship or figure salient to an individual using an attachment SP stimulus. SP is believed to make mental representations of attachment figures symbolically

available at Mikulincer and Shaver's (2003) appraisal level of their adult attachment model (refer to appendix 1), and is believed to facilitate access to secure IWMs to facilitate implementation of the primary attachment strategy to increase the individual's sense of felt-security. A wealth of aforementioned SP research has evidenced this theoretical model of attachment and emotional regulation using non-clinical samples. It is theorised (Coan 2008; Coan 2010), and evidenced in behavioural (Collins & Ford, 2010) and fMRI research (Coan, et al., 2006; Coan et al., 2013), that secure attachment relationships are the most effective way to regulate distress and negative affect. In addition, recent research has showed post-SP reduced amygdala activation in a highly anxious analogue sample using a similar methodology to the current study (Norman et al., submitted).

However, the findings here suggest that for individuals with interpersonal trauma, the notion of achieving 'felt-security' (i.e. the safe experience of feeling close to an attachment figure) by attempting to activate a secure IWM through SP might be different to that of someone with a less insecure global attachment style. It may be theorised that something quite different happens for this group of individuals at the appraisal of attachment figure availability level of Mikulincer & Shaver's model of attachment system activation. Implementation of the primary attachment strategy in order to emotionally regulate appears to be unsuccessful for this group of individuals when primed with secure attachment-oriented pictures. This is reflected in the findings of no post-SP favourable changes in AB or amygdala activation, and an unexpected finding of significantly greater amygdala activation in security-primed participants. The latter finding suggests a response associated with emotional dysregulation following secure attachment priming.

It is thought that for individuals with adverse childhood experiences, such as those involving physical, sexual and emotional abuse, the subjective experience of attempts to achieve 'felt-security' through activation of the attachment system may be one of ambivalence or potential danger (Allen, Fonagy, & Bateman, 2008). Accordingly, the short-term activation

of the attachment system in interpersonally traumatised individuals has been found to be associated with neural dysregulation (Buchheim et al., 2006) and the amplification of distress (Allen et al., 2008; Herman, 1992; Zlotnick et al., 1996). This would go some way in explaining the lack of reduction in AB and the unexpected heightened neural activation finding in those participants exposed to attachment security-primes.

An additional consideration should be made of the neural activation paradigm employed which utilised angry and fearful face stimuli. Research has demonstrated that individuals who have experienced profound early interpersonal trauma may have more exaggerated neurological responses to emotional faces, particularly those depicting anger and fear (Donegan et al., 2003; Garrett et al., 2012). This, combined with greater trait attachment anxiety in the SP condition, suggests that an additional trauma-specific effect may have been operating in the emotional faces matching task, where a large proportion of the sample might have possessed an increased sensitivity to angry and fearful faces, giving rise to inflated neural responses in the amygdala. This may have acted to confound the neural results of the study and contraindicate any gains of SP on participants after being exposed to such stimuli by hyper-activating the attachment system.

Furthermore, through exposure to emotionally threatening faces, there is a possibility that individuals may have engaged in processes known to be common reactions to threat in interpersonally traumatised individuals such as emotional blunting or dissociation (Lanius, 2002; Lanius, 2010; van der Kolk, 1996), which may have impacted on neural responses. In hindsight, a measure of dissociative experiences in participants may have allowed us to examine this further.

It is maintained that regardless of trauma-type or attachment disposition, most individuals are likely to possess elements of a secure IWM (Baldwin et al., 1996; Mikulincer & Shaver, 2007b) or “islands of security” as emphasized by Allen (2011). However, the issue may be of accessibility to these representations by individuals with profound early interpersonal

traumatic experiences. Individuals learn fundamental skills of effective emotional regulation through the early co-regulation achieved within the context of a safe attachment relationship (Bowlby, 1973; Bowlby 1982, Main 1990). It is likely that within the sample employed, such experiences of co-regulation with secure and consistently available others are limited. Therefore, single exposure to secure attachment primes for interpersonally traumatised individuals may act to just dysregulate the individual, and maintain the hyper-vigilance associated with AB.

SP is arguably a similar process to what happens in psychotherapy. In psychotherapy, the individual experiences repeated exposure to real-life representations of a safe, consistently available and responsive attachment relationship figure (Norcross, 2011). Over time, if a therapeutic relationship develops and is maintained, it is thought that the client's predominant IWMs and emotion regulation strategies change in the direction of greater security (Mikulincer & Shaver, 2007a). Indeed, it is well established that the most important predictor of successful outcome and mechanism of change in any therapy is the maintenance of a secure therapeutic relationship (Lambert & Barley, 2001). Future research may wish to examine the impact of repeated SP in interpersonally traumatised individuals, which may grant more successful access to secure internal attachment representations. Accordingly, studies have obtained stronger and longer lasting effects of SP on different interpersonal (views of self and relationships) and behavioural variables (mood, stress, anxiety, fear response) using repeated SP methods (Beckes et al., 2010; Carnelley & Rowe, 2007; Dandeneau et al., 2007; Gillath et al., 2008).

Limitations and Future Research Recommendations

The study has a number of limitations which may have impacted on its results. Due to recruitment challenges and a resulting small sample size, the study was underpowered for the between-group analyses, and it is likely that this study only achieved enough power to detect large effect sizes associated with SP. The effect of SP on AB findings observed do show a trend

in the hypothesized direction, but do not reach significance, which suggests that some secure internal representations may have been accessed by security-primed individuals. It is possible that with greater power, the effect of SP may be seen to significantly reduce AB.

A broad recruitment inclusion criteria was utilised, advertising for individuals who have experiences which fall into the broad category of a 'trauma' (Joseph et al., 1997). This was combined with a strict safety exclusion criteria which excluded many (approximately 20% of those screened) of whom have had metal implants resulting from arguably less attachment-related interpersonal traumas such as motor vehicle accidents or combat-related experiences. This may have acted to bias the study sample toward that of more interpersonal trauma experiences. It may be argued that the sample characteristics may over-represent experiences which are captured by Herman's (1992; 1997) concept of 'complex PTSD'; that is prolonged interpersonal trauma that has a profound impact on attachment orientation, emotional regulation abilities, and the ability to experience safety within attachment relationships (Stein, Friedman, & Blanco, 2012). Furthermore, despite stratified sampling methods, the SP group were found to be significantly more anxiously attached compared to the control condition, which made the between-group comparison less pure, which may further account for the unexpected greater amygdala activation finding in the SP condition.

Future qualitative research–such as that conducted by Carnelley & Rowe (2010) using a non-clinical sample, would be beneficial to examine how SP is experienced by interpersonally traumatised individuals, and the nature of the themes that are present in their thoughts as they experience a SP procedure. This may increase our understanding of some of the barriers which exists for this group of individuals in achieving a sense of felt-security through exposure to attachment-related stimuli.

This study chose to use a validated fMRI task paradigm which has been proven to elicit amygdala activation. As discussed, this may have acted to contraindicate security-priming gains

given the nature of the sample recruited. Future research may wish to implement an alternative fMRI paradigm to recruit activation of the amygdala when using interpersonal trauma samples.

The study's security-priming materials were validated using a sample of student undergraduates, and this may have been non-representative of a clinical trauma sample. It is possible that the visual secure attachment priming stimuli failed to effectively access a secure IWM in the SP condition given that self-reported felt-security did not increase following SP. A generic set of SP picture stimuli were utilised in this study depicting strangers enjoying close attachment relationships. Some previous successful SP studies that have reported post-priming increases in felt-security have employed the use of personalised secure attachment primes (Arikan et al., 2012; Eisenberger et al., 2011; Mikulincer et al., 2005), such as family pictures or names of close attachment figures. Future research is needed to investigate the efficacy of different types of attachment priming materials, particularly to elucidate if personalised priming stimuli offer greater potency in priming secure attachment internal representations.

Given that current empirical findings currently favour no particular approach (Gillath et al., 2008; Mikulincer et al., 2005); an explicit priming method was selected over a subliminal method for this study as it has been shown to be effective in a similar study using a non-traumatised sample with elevated levels of anxiety (Norman et al., submitted). A non-subliminal priming method was also used to avoid deception of participants in order to make recruitment of a clinical sample ethically viable. However, the attachment pictures used may have served to remind individuals of their interpersonal traumatic experiences, which may have compounded the effect of SP. Indeed, this was the feedback offered by one participant following testing. Future research may wish to employ subliminal secure attachment priming methodologies to address this issue, which would also be less vulnerable to potential demand characteristics.

Future research is needed to examine if SP may be found to be more successful in reducing activation in threat-detection centres and AB using individuals who have experienced

non-interpersonal and accidental traumas such as motor vehicle accident, or victims of natural disasters.

This study has addressed an important gap in the literature by exploring the use of attachment security-priming in a trauma-exposed clinical sample. It has elucidated important differences between a clinically traumatised sample and the majority of existing research which have utilised healthy-control samples, when examining the impact of attempting to activate secure attachment internal representations using attachment security-priming.

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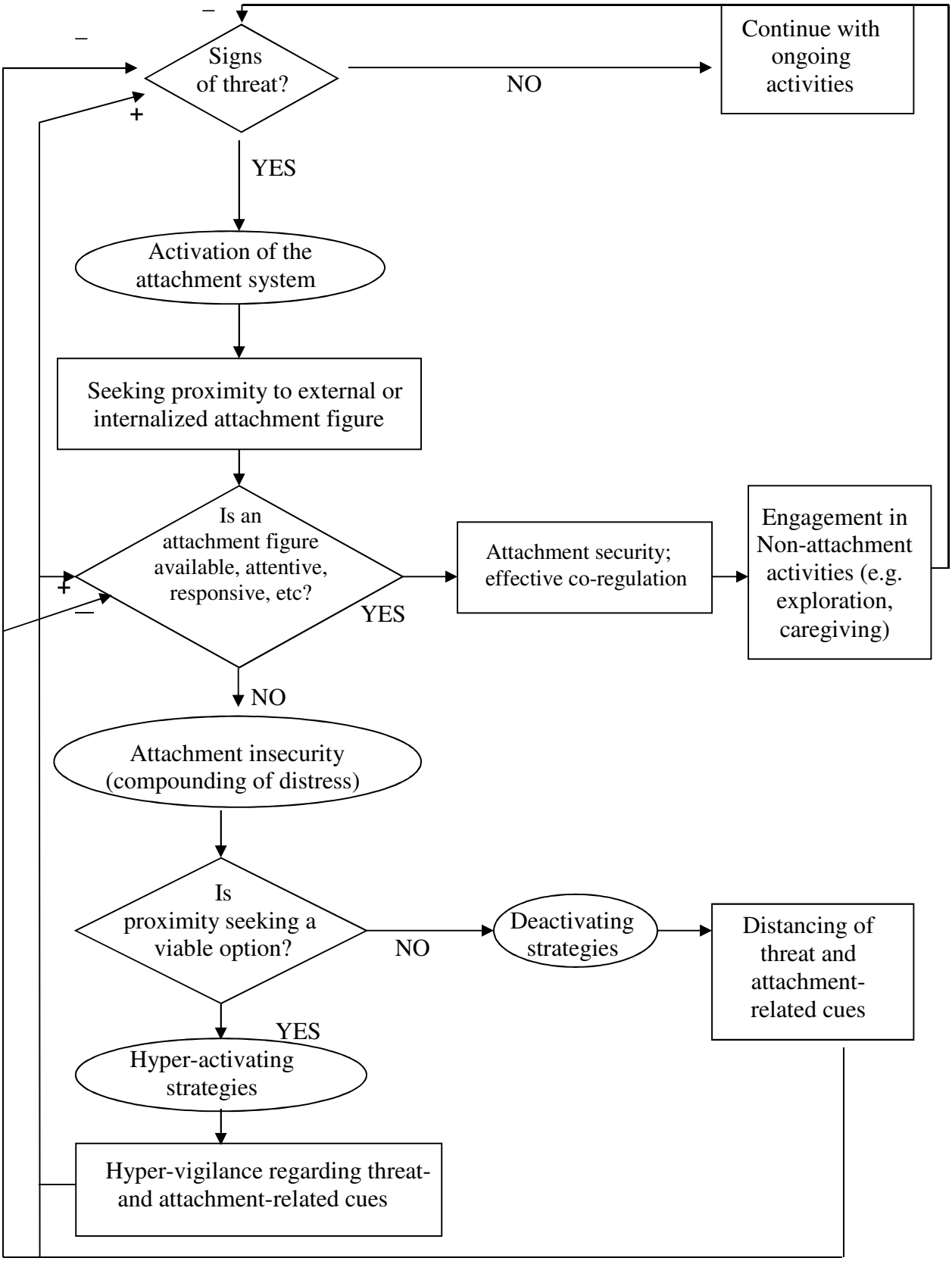
Expanded Appendices

Appendix 1. *An adaptation of Mikulincer and Shaver's (2003) three-phase theoretical model of attachment-system activation and dynamics in adulthood.*



Appendix 2. *Expanded Method*

This section includes information supplementing the method section of the main manuscript. Information not included in the main manuscript is provided here.

1. Ethics Approval Letters

    School of Psychology ethics committee

    National Research Ethics Service (NRES) Committee
2. Telephone Screening Interview
3. Participant Information Sheet and Consent Form
4. Priming Stimuli Examples
5. Dot-Probe Paradigm
6. Matching Task Paradigm
7. fMRI Glossary of Terms

1. Ethics Approval Letters

Psychology Research Ethics Committee

Psychology, College of Life & Environmental Sciences

Washington Singer Laboratories
Perry Road
Exeter
EX4 4QG

Telephone +44 (0)1392 724611
Fax +44 (0)1392 724623
Email Marilyn.evans@exeter.ac.uk

To: **Andrew Iles**
From: **Cris Burgess**
CC: **Anke Karl**
Re: **Application 2011/552 Ethics Committee**
Date: **25th June 2012**

The School of Psychology Ethics Committee has now discussed your application, ***2011/552 – Does secure attachment priming reduce attentional bias in trauma patients*** . The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

Cris Burgess
Chair of Psychology Research Ethics Committee

NHS
Health Research Authority
NRES Committee South West - Central Bristol

Whitefriars
Level 3, Block B
Lewin's Mead
Bristol
BS1 2NT
Email: ubh-tr.SouthWest3@nhs.net

Telephone: 0117 342 1335
Facsimile: 0117 342 0445

06 June 2012

Mr Andrew Iles
Trainee Clinical Psychologist
Taunton and Somerset NHS Foundation Trust
Musgrove Park Hospital
Taunton
TA1 5DA

Dear Mr Iles,

Study title: **DOES PRIMING A SECURE ATTACHMENT REDUCE ATTENTIONAL BIAS IN TRAUMA PATIENTS? AN fMRI STUDY.**

REC reference: **12/SW/0139**

The Research Ethics Committee reviewed the above application at the meeting held on 25 May 2012. Thank you for attending to discuss the study.

Issues Discussed

- The Committee asked you as to why you intend to include only the right handed people in the study. You explained that this was because the emotional processing often happens in particular hemispheres of the brain, and that varies if a person is right handed or left handed. Therefore in order to get homogeneous response you intend to include only right handed.

- The Committee asked you as to how would you randomise the treatment and which group will get what treatment and on what basis. You explained that you will be using random number generator software to randomise and each participant will be assigned a number and you would also stratify in order to counter severity in any particular group.

- The Committee suggested to you that the PIS contains too much information about the MRI scans. This can be reduced to simplify the PIS. You agreed to follow the Committee's advice.

- The Committee asked you as to why you intend to exclude people with tattoos. You explained that only those who have piercings will be excluded as it could interfere with the MRI scans.

- The Committee noted that the letter from GP is actually from the University and

not directly from the GP and no cover letter is included. The Committee suggested including a cover letter from the GP along with the University letter. You agreed to follow the Committee's advice.

- The Committee noted that study includes option for the participants to reply by email. The Committee asked you as to how would you make sure that the email addresses of the participants are kept safe and confidential. You confirmed that all email addresses will be destroyed once the study is finished, or before that, if they are not included in the study.

- The Committee asked you as to why you intend to exclude people with English as second language. You explained that people from different cultures and languages may have different brain processes and in order to have a homogenous group, you are excluding them. The Committee was satisfied with your response.

Ethical opinion

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Ethical review of research sites

NHS Sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non NHS sites

The Committee has not yet been notified of the outcome of any site-specific assessment (SSA) for the non-NHS research site(s) taking part in this study. The favourable opinion does not therefore apply to any non-NHS site at present. I will write to you again as soon as one Research Ethics Committee has notified the outcome of a SSA. In the meantime no study procedures should be initiated at non-NHS sites.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

1. *Issues related with bereavement may occur at different times with different participants and therefore they might react differently to them. Explain as to how this would be managed, especially as the control group to compare them with, also suffer from PTSD.*

2. *Name of the REC needs to be corrected in the PIS.*

3. *PIS contains too much information about the MRI scans. This can be reduced to simplify the PIS.*

4. *Provide confirmation that all email addresses of the respondents/participants will be deleted once the study is finished.*

5. *Letter from GP is actually from the University and not directly from the GP, and no cover letter is included. A cover letter from the GP should be included along with the University letter.*

6. *Winning £25 shopping voucher on poster adverts could be seen as inducement to participate. This may just be included in the PIS but not on the adverts.*

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

It is responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

You should notify the REC in writing once all conditions have been met (except for site approvals from host organisations) and provide copies of any revised documentation with updated version numbers. Confirmation should also be provided to host organisations together with relevant documentation

Approved documents
The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Advertisement	1. Leaflet	20 February 2012
Advertisement	1. Poster	20 February 2012
Covering Letter		13 April 2012
Evidence of insurance or indemnity	Ins. Cert.	11 July 2011
GP/Consultant Information Sheets	1	20 February 2012
Investigator CV	A Iles	20 February 2012
Letter from Sponsor	Letter from University of Exeter	11 April 2012
Letter of invitation to participant	1	20 February 2012
Other: CV for Dr A Karl		04 April 2012
Other: ETISR-SF		
Other: DASS		
Other: Relationship Structures Questionnaire		
Other: Attentional Control Scale		
Other: Participant Debriefing Sheet	1	20 February 2012
Other: Telephone screening script	1	20 February 2012
Other: Consent to be contacted for future research	1	20 February 2012
Other: Participant Confirmation letter with directions	1	20 February 2012
Other: Academic references		
Participant Consent Form	1	20 February 2012
Participant Consent Form: MRI Unit Consent form	1	20 February 2012

Participant Information Sheet	1	20 February 2012
Protocol	1	20 February 2012
Questionnaire: Face Matching Experimental Paradigm	1	20 February 2012
Questionnaire: Dot-Probe Experimental Paradigm	1	20 February 2012
Questionnaire: Attachment Priming paradigm and stimuli	1	20 February 2012
Questionnaire: PC-PTSD		
Questionnaire: PCL-C		
Questionnaire: ERQ		
Questionnaire: Felt Security Scale		
Questionnaire: Self-Assessment Manikin		
Questionnaire: Edinburgh Handedness Inventory		
REC application	3.4	13 April 2012

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback
You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

12/SW/0139 **Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project

Yours sincerely,

Dr PamelaCairns
Chair

Email: rajat.khullar@nhs.net

Enclosures: *List of names and professions of members who were present at the meeting and those who submitted written comments*
"After ethical review – guidance for researchers"

Copy to: *Dr Michael Wykes*
Ms Judith Belam, Devon Partnership NHS Trust
Research & Development Directorate

2. Telephone Screening Interview

Screening Interview

Investigator: _____ Date: _____

Assigned:

- Code: _____
- Appointment_____

How recruited:_____
Name: _____
Age_____ DOB_____
Address_____
Phone number_____
Gender: F/M
Marital Status:_____ Highest Education:_____
Employment Status (FT/PT):_____ Occupation:_____

Hi, my name is […] and I'm a postgraduate researcher at the University of Exeter.
If participant calls: **Thanks for your calling! What can I do for you?**
If participant has written an e-mail: **Thanks for your e-mail which express your interest in taking part in our study.**

As we explained in our flyers and press advertisements, we are studying the behavioural psychological consequences of trauma. The aim is to investigate behavioural and brain activity differences in emotional processing in the hope of understanding the effects of trauma better with a hope of informing the development of new effective treatments.

Do you have time to talk at the moment or would you like me to call back later?
If person has no time: **When is a good time for me to call you?,** *note and call back later*

If you are still interested in taking part in this study after my explanation, the study will involve one appointment for you at the University of Exeter, lasting approximately one and a half hours. I will send you an information pack and some questionnaires to complete before the day of testing to bring with you on the day. During the first part of your visit I will ask you to complete some brief questionnaires about your general mood.

The second part of you visit will involve completing some basic tasks whilst being scanned inside a magnetic resonance imaging machine (MRI machine). This will include an anatomical and functional MRI scan, which will take 1 hour 30 minutes of your time. The first fifteen minutes or so will be spent setting-up the equipment and the actual scanning session lasts up to 1 hour.

This study is restricted to completely non-invasive procedures: no injections are involved. Before you go into the scanner we will also tell you exactly how long we expect your scan to take, so that you can decide whether you are happy to lie still for that long - remember that you are free to withdraw from this study at any time, without giving a reason and all of the information that we collect about you will be kept completely confidential. The information that we gather is purely for research purposes. A full information pack about the scanning procedures will be sent to you in the post.

Do you have any other questions? Answer any questions that have been asked.

Are you still interested in taking part?

If no: **Thanks for calling! Bye.**
If yes: **Thank you, we are pleased about your intention to assist us.**

Is it OK for you if I take again about 10 to 15 minutes of your time to run through some brief questions? You are free to stop at any time. All information collected will be kept completely confidential.

If not a good time for telephone call: **When is a good time for me to call you to run through the screening questionnaires?**

Brief screening about trauma?

			Include	**Check/exclude***
1.	When was the trauma?	Date:	> 6 months	< 6 months (invite person later)
2.	Do you mind me asking the nature of the trauma?			
3.	Was your or other people's life in danger?		Yes	No

**If most answers fall into this column but you are not sure and would like to discuss with the please say at the end of telephone screening that you have to check and get back to them.*

I must now ask you some health-related questions if this is okay?

The next questions will only require a simple yes or no answer.

		Details	**Include**	**Check/exclude***
1.	Are you right handed? ***Administer Edinburgh Handedness Inventory.***		Yes	No
2	Are you currently taking any medication? Antidepressent use? (how long/recent changes?)		No No recent change	Cardiovascular medication Recent change
3	Current or history of mental health illness?			
4	History of neurological illness/head injuries?		Yes	No
5	Current use of illicit substances?		No	Yes
6	Current use of alcohol?		<20 units/week	>20 units/week

*If the person has any queries about their mental health:
If you have any concerns about your health with respect to the accident, your general practitioner is the best person to speak to.

- *Administer*
  - *PC-PTSD (2 minutes)*
  - *DASS-21 (5 minutes)*

I'd also like to ask you some more questions about your health, if that's OK? You have the right to withdraw from the screening and subsequent scanning if you find the questions unacceptably intrusive. The information you provide will be treated as strictly confidential and will be held in secure conditions.

Please answer all questions	*Circle answer*
1. Have you been fitted with a pacemaker, or any other implanted device?	YES/NO
2. Have you any surgical clips, aneurysm clips, shunts or stents in your body?	YES/NO
3. Have you had a heart valve replacement	YES/NO
4. Have you ever had any metal fragments in your eyes?	YES/NO
5. Have you had a cochlear implant fitted	YES/NO
6. Do you wear a hearing aid?	YES/NO
7. Do you have any other mechanical/electrical or magnetically operated devices in or on your	YES/NO
8. Have you ever had any metal fragments, e.g. shrapnel in any other part of your body?	YES/NO
9. Have you any surgically implanted metal in any part of your body (e.g. joint replacement or	YES/NO
10. Have you ever had any surgery that might have involved metal implants of which you are not	YES/NO
11.Do you have a catheter fitted?	YES/NO
12.Do you have any intra-venous devices fitted (including stents and filters)	YES/NO
13. Do you have any Tattoos?	YES/NO
14. Is there any possibility that you might be pregnant?	YES/NO
15. Have you been sterilised using clips?	YES/NO
16. Do you have a contraceptive coil (IUD) installed?	YES/NO
17. Do you have **any** dental work (including dentures, crowns, bridgework, braces) in your	YES/NO
18. Have you ever suffered from any of: epilepsy, diabetes or thermoregulatory problems?	YES/NO
19. Have you ever suffered from any heart disease?	YES/NO
20. Do you have any permanent eye makeup?	YES/NO
21. Have you ever suffered with claustrophobia?	YES/NO

DETAILS:_____
_____
_____
_____

*If the person has any of the conditions on the checklist:
I'm really sorry but for safety reasons you won't be able to take part in the study. I'd like to thank you for your time and your interest in the study

If eligible:
Arrange time and date of appointment, and mail out details.

Thank you, we look forward seeing you on […].

Bye.

3. Participant Information Sheet and Consent Form

fMRI Participant Information Sheet

AI V2 180612

Lead Investigator: Andrew Iles (ati201@exeter.ac.uk); Dr Anke Karl;(A.Karl@exeter.ac.uk); Dr Natalia Lawrence (Natalia.Lawrence@exeter.ac.uk).

Study title: Brain activity and traumatic life events

Introduction

My name is Andrew Iles and I am a Trainee Clinical Psychologist. I am doing some research to better understand the behavioural and brain activity associated with experiencing a traumatic life event that is difficult to come to terms with. Following a bad experience, most people recover given time, but some people experience stress reactions that do not go away or get worse with time, and may be told that they have Post-Traumatic Stress Disorder (PTSD). We are conducting an interesting new study at the University of Exeter investigating difficulties in coming to terms with traumatic experiences. In particular, we would like to speak to those who develop stress reactions after a bad experience in order to better understand this and design a new psychological treatment.

If you feel this reflects your own experiences, I would like to invite you to take part in this research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this information sheet.

What is the purpose of the study?

The aim of the study is to look at how the brain responds to different things in our environment following the experiencing of a traumatic life event or 'a trauma'. We are interested in speaking to individuals who have ***experienced any type of traumatic life event which they feel remains difficult to come to terms with***, such as a motor vehicle accident, have been a victim of crime such as an attack, difficult combat/war related experiences, the sudden and unexpected death of a loved one, a sudden unexpected illness (e.g. heart attack), or anyone who has been told they have post-traumatic stress disorder (PTSD). Such individuals may suffer with persistent bad memories, stress and nightmares. We are particularly interested in what happens in the brain to when individuals see different emotional words and pictures.

The results gained may help our understanding of why the difficulties some people have following a stressful life experience do not get better, and may help develop a new psychological treatment for trauma-related difficulties.

We will be scanning brain activity using a magnetic resonance imaging (MRI) machine while you will be asked to carry out different tasks. The study will last no longer than 1.5 hours.

Why have I been chosen?

Following a bad experience, most people recover given time, but some people experience stress reactions that do not go away or get worse with time. We would like to speak to those individuals who develop stress reactions after a bad experience in order to design a new treatment.

As a volunteer you responded to our request for people who have experienced a traumatic life event which has been difficult to come to terms with.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign the attached consent form. If you decide to take part you are still free to withdraw at any time, without giving a reason.

How many sessions are involved?

The study will involve one appointment which will take place at the University of Exeter and which will last approximately 1.5 hours. Before your appointment we will arrange a convenient time to speak to you on the phone and ask you some questions about the difficult life event you experienced and some questions about your general health. We would also send you some questionnaires to complete and bring along with you on the study day which will take up to 30 minutes to complete.

During your visit to the University we will ask you to complete some brief questionnaires and to answer some questions relating to your personality and your general mood. During the second part of your visit we will ask you to carry out some different basic tasks whilst lying comfortably in an MRI scanner, which will take an anatomical scan and functional MRI scan. These include (a) watching a view screen and pressing a button as fast as you can when you see a dot on the screen (b) matching up some pairs of faces (c) and looking at some images. You will be given detailed instructions for each task before you are asked to carry it out. You will be asked to lie in the scanner for no longer than one hour. More detailed information about the MRI scan can be found further on in this information sheet

In this study you may be faced with threatening or unpleasant words and faces.

At the end of the study you will be provided with additional information and feedback about the purpose of the study and any further questions you may have will be answered by the researchers.

What do I have to do before the scanning sessions?

There are no restrictions on lifestyle or diet before taking part in this study. As the scan can be quite long, you may wish to use the toilet before the scan.

What are the possible benefits of taking part?

There are no direct benefits to you, however the information that we get from this study may help to learn more about psychological consequences of traumatic life experiences and help to improve the psychological treatment for people who may suffer and find it hard to come to terms with such experiences. This study involves the recording of typical brain function. The scans are not intended to provide a medical diagnosis or a clean 'bill of health' – and the person conducting your scans will not be able to comment on the results of your scans.

As a thank you for volunteering your time for the study, you will be entered into a prize draw to win £25 shopping vouchers of your choice. We will also pay your travel expenses for attending the University.

What happens if you find something unusual on the scan?

The researchers involved do not have expertise in MRI diagnosis, as they are psychologists or allied scientists and are not medical doctors. You should not regard these research scans as a medical screening procedure. Occasionally when we image participants, the researchers may be concerned that a potential abnormality may exist on the scan. In this case, we will ask for your consent to send a copy of your scan to your General Practitioner for further investigation.

It is important that you realise that these scans will not provide any information that may help in the diagnosis of any medical condition. If you do have any health concerns, you should contact a qualified medical practitioner in the normal way.

Are the procedure and results confidential?

All information which is collected about you during the course of this research will be kept strictly confidential. We may share the data we collect with researchers at other institutions, but any information which leaves the research centre will have your name and address removed so you cannot be recognised from it. Any information about your identity obtained from this research will be kept private. In any sort of report we might publish, we will not include information that will make it possible for other people to know your name or identify you in any way. You will be simply referred to by your gender, age and possibly some characteristic such as left or right handedness.

What will happen to the results of the research study?

The data obtained through your participation will be combined with that from other participants as part of a scientific study to appear in scientific journals. Where appropriate, the results of this study will also be presented at medical and scientific conferences. You will not be identified in any report, presentation or publication. The results of this study will also help us to design future research projects, and possibly lead to new methods of diagnosis or treatment for trauma related conditions. The data will be held for ten years from the date of collection at the University of Exeter under the management of Dr. Anke Karl (Lead Supervisor).

What will happen if I do not want to carry on with the study?

Nothing will happen. If you no longer wish to participate, you can do so whenever you wish without giving a reason and without any loss of current treatment or any other negative consequences. You may withdraw your data from the study up to the date of December 2012 when the project will be written up.

Who is organising and funding the research?

The study is funded and managed by the University of Exeter.

Who has reviewed the study?

The study has been reviewed and approved by the Central Bristol Research Ethics Committee (ref. 12/SW/0139), and the local National Health Service Research and Development Department. If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee (Chris Burgess), Department of Psychology, University of Exeter, Perry Road, Exeter, EX4 4QG.

Please read the attached MRI information and safety sheet

Contact for Further Information

Andrew Iles or Dr Anke Karl
School of Life and Environment Sciences,
University of Exeter
Perry Road,
EXETER
EX4 4QG

Office number: 01392 725271
Email: *ati201@exeter.ac.uk/a.karl@exeter.ac.uk*

Helplines

ASSIST (Assistance Support and Self-help In Surviving Trauma: Mon-Fri 10am – 4pm)
www.traumatic-stress.freeserve.co.uk
01788 560800

Samaritans (24 hours a day)
www.samaritans.org
08457 909090

UNIVERSITY OF EXETER **– MRI UNIT CONSENT FORM**

Research Study: ***Brain activity and traumatic life events (V1 200212)***

NAME/CODE OF PARTICIPANT …… Sex: M / F Date of Birth:……

Please read the Participant Information Sheet and then read and initial the following statements carefully and then add your signature. If you have any questions, please ask the person who gave you this form. You are under no pressure to give your consent and you are free to withdraw from the MRI examination at any time. By signing the form you are agreeing to the following:

- I understand that I am to take part in a functional MRI experiment in which I will be placed in the scanning machine for up to an hour, while my brain activity will be measured by the machine. During the scan I will be shown visual images, such as pictures faces and words, and will be asked to make simple judgments about them. I will make responses using a button-box. I will also be asked to fill in several questionnaires about my mood. ☐
- I confirm that I have read and understand the fMRI Participant Information Sheet dated 18.06.12 (version 1.0) and have had the opportunity to ask questions about it. ☐
- I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason. ☐
- I understand that I am free to ask any questions at any time and that I am free to withdraw or discuss my concerns with the lead researchers (Mr Andrew Iles or Dr. Anke Karl). ☐
- I also understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study. ☐
- I understand that I can talk to the operators via an intercom and that I will be given an alarm that I can use at any time to end the scan and signal to the operator. ☐
- I understand that I can require, for any reason and at any time that I be immediately removed from the MRI machine. ☐
- I understand and agree that the MRI scan is not a medical screening procedure and that the researchers are not qualified to provide a clinical diagnosis or identify potential abnormalities. However, if the researchers are concerned that there may be a potential abnormality on the scan, I consent to them disclosing the scan to the my General Practitioner for further investigation. ☐
- I have completed the initial screening form and have been told that it is safe for me to be scanned. ☐
- I understand that the information provided by me will be held confidentially, such that only the researchers can trace this information back to me individually. The information will be retained for up to 10 years when it will be deleted/destroyed. I understand that I can ask for the information I provide to be deleted/destroyed upto December 2012 when the project will be written up and, in accordance with the Data Protection Act, I can have access to the information at any time. ☐

I, _____(NAME) consent to participate in the study conducted by School of Psychology, University of Exeter.

Signed:

Date:

Do not write beneath this line, For Staff Use Only

UNIQUE IDENTIFIER:……

Statement by the Researcher carrying out the scan:

I certify that the above participant signed this form in my presence. I am satisfied that the participant fully understands the statement made and I certify that he/she had adequate opportunity to ask questions about the procedure before signing.

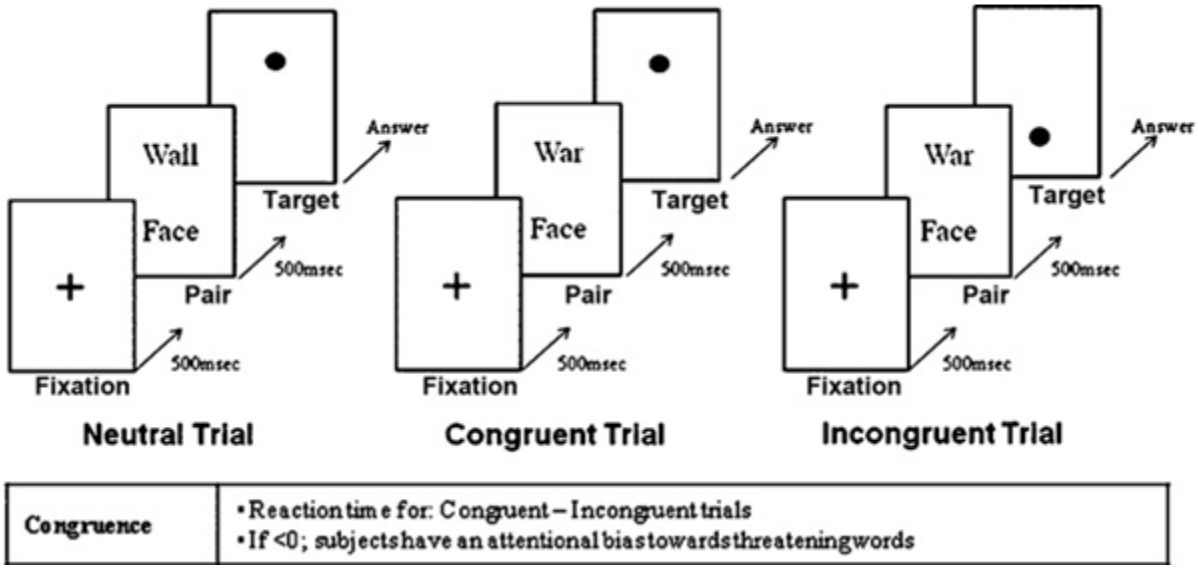
Signature…… Name…… Date ……

4. Priming Stimuli Examples

Example stimuli used to (a) security-prime or (b) neutrally-prime participants.

5. Dot-Probe Paradigm

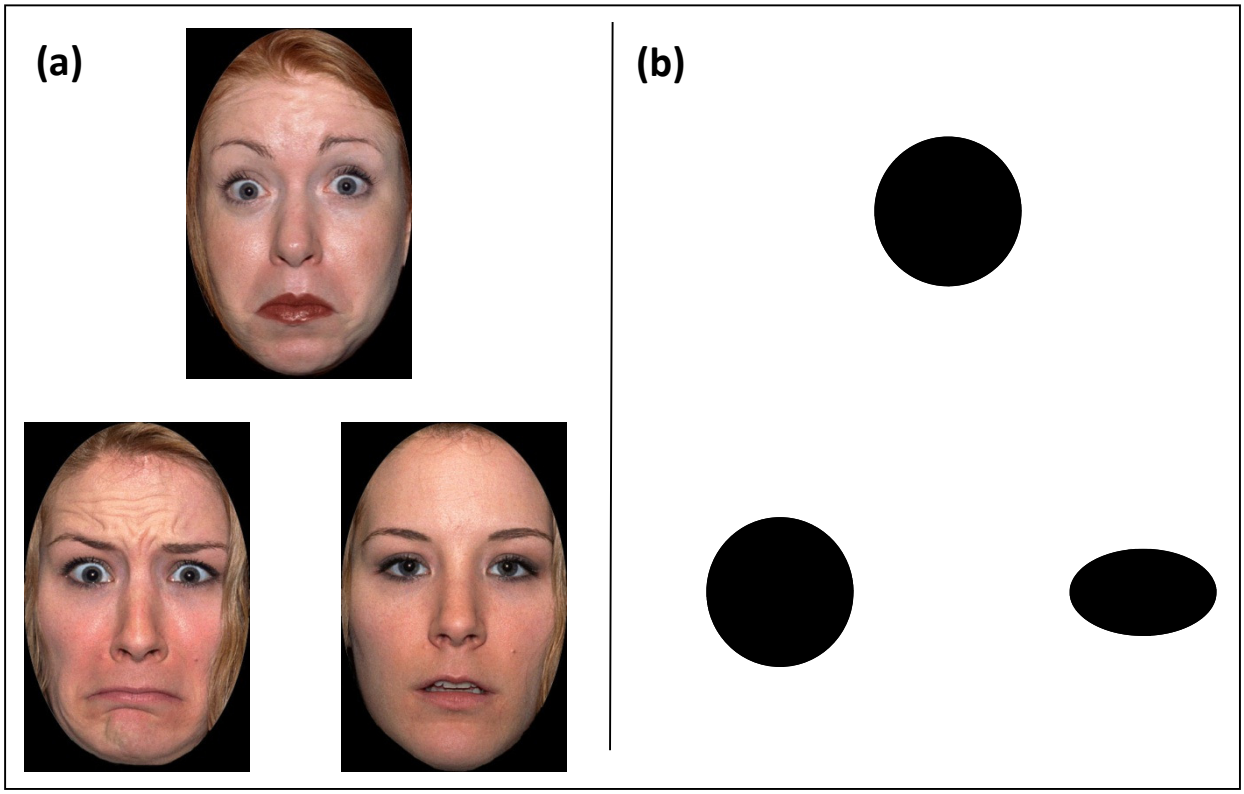
Dot-probe task with neutral, congruent, and incongruent trials and subsequent calculation of AB indices. Figure adapted from El Khoury-Malhame et al., (2011b).



Congruence	• Reaction time for: Congruent – Incongruent trials • If <0; subjects have an attentional bias towards threatening words

6. Matching Task Paradigm

Example stimuli used in (a) emotional faces blocks and (b) control/neutral blocks on the matching task paradigm.



7. fMRI Glossary of Terms

Activation: When a voxel responds positively to a condition (or stimulus), i.e. the intensity of the fMRI signal in the voxel increases over time in response to the condition, it is said to be 'activated' (see also cluster).

BOLD (Blood Oxygen Level Dependent): The change in signal that is caused by alterations in the amount of oxygenated haemoglobin in the brain.

Boxcar design: An fMRI experimental design in which two conditions are alternated over the course of a scan in a single subject. This is a *categorical, blocked, subtractive design*. The experiment examines two levels of a category: "experimental" blocks are alternated with "control" blocks, which are designed to evoke cognitive processes present in the experimental block except for the primary cognitive process of interest. Cognitive subtraction then allows one to attribute differences in neural activity between the two conditions to the cognitive process of interest, which has been putatively isolated by subtraction.

Cluster: A group of adjacent voxels which all display activation (an increase in BOLD signal) simultaneously.

Contrast: A representation of the differences between the intensity of signal in the brain, and how these differences relate to brain activity.

Echo Planar Imaging (EPI): An MRI technique that allows the very fast acquisition of images allowing signal changes to be observed over relatively short periods of time (1-3

seconds). Although a very fast technique, image quality is generally poor and does not allow accurate identification of anatomical landmarks.

Event related design: A technique which allows for measurement of brain activity in response to very brief 'events'.

FLAME: FMRIB's Local Analysis of Mixed Effects

FLIRT: FMRIB's Linear Image Registration Tool.

FMRIB: Functional MRI of Brain.

Functional Magnetic Resonance Imaging (fMRI): A technique for studying brain function through changes in cerebral blood flow and cerebral blood oxygenation, as these are correlated with neuronal activity.

Gaussian Smoothing: A process that averages data from neighbouring and near neighbouring voxels. The way the averaging takes place is dictated by a mathematical shape known as a Gaussian, which places greater emphasis within the averaging procedure on voxels that are nearest to each other rather than ones which are further apart.

Normalisation: Refers to the process of modifying the shape of the brain so that it matches a standard brain. This allows a large number of brain images from different individuals to be compared (also referred to as *registration to standard space).*

Quadrature coil. A coil that produces an *RF* field with circular polarization by providing RF feed points that are out of phase by 90°.

Radiofrequency (RF). The wave *frequency* used in MRI studies, which is commonly in the *megahertz* (MHz) range.

SENSE: SENSetivity encoding: an MRI technique for scan time reduction.

Slice: A single image at a specific orientation.

Smoothing: A process that averages data from neighbouring voxels and near neighbouring voxels (see also Gaussian Smoothing)

Structural Scan (Structural Scan Sequence): A high-resolution scan which results in images of high quality allowing the accurate identification of brain structures. These take several minutes to acquire.

T (Tesla): A unit of magnetic strength.

TR (Repetition Time): The time between consecutive image acquisitions. This parameter determines how fast you can see signal changes within the brain.

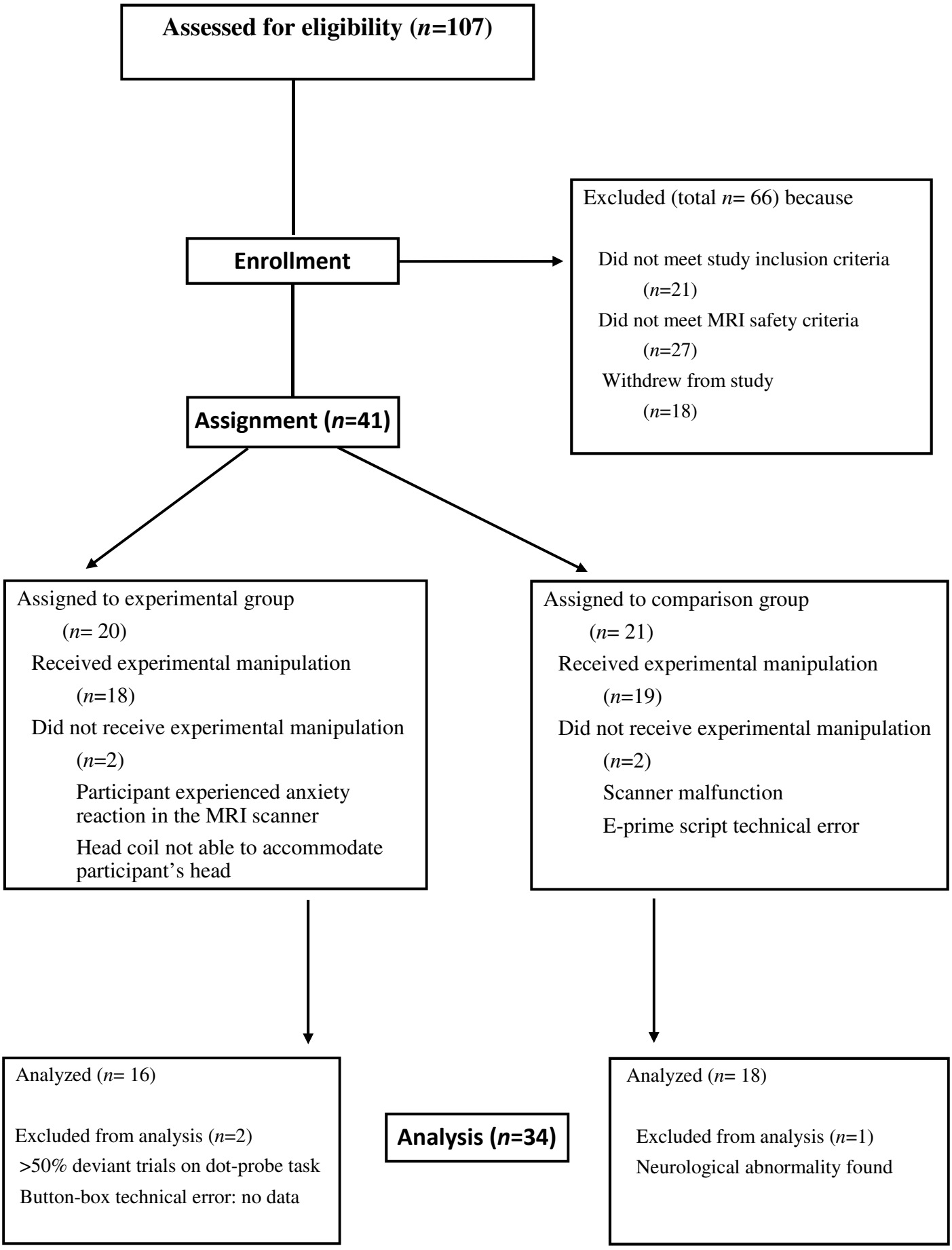
Voxel: The smallest unit of volume within the brain e.g. 3mm x 3mm x 3mm.

Appendix 3. *Expanded Results*

This section includes information supplementing the results section of the main manuscript. Information not included in the main manuscript is provided here.

1. Participant Flow Diagram
2. Table of Zero Order Correlations

1. Participant Flow Diagram



2. Table of Zero Order Correlations

Independent/ moderator variables	Attentional bias	Right dorsal amygdala activation
Priming condition	.22	.43*
Attachment anxiety	-.13	.27
Attachment avoidance	-.26	.21
Priming condition X attachment anxiety	-.15	.26
Priming condition X attachment avoidance	-.27	.22

Note. *$p < .05$.

Appendix 4. *Dissemination Plan*

The findings of this study will be disseminated in the following ways:

1. At a presentation to service users, trainee clinical psychologists, and staff from the Exeter DClinPsy programme (June 2013).
2. At a presentation to qualified clinical psychologists within an adult mental health service (May, 2013).
3. In the form of a peer reviewed journal article to be prepared and submitted to the Journal of Abnormal Psychology (Sept, 2013).

Appendix 5. *Instructions to Authors - Journal of Abnormal Psychology*

Submission

Submit manuscripts electronically (in .rtf or .doc format) via the Manuscript Submission Portal.

Sherryl H. Goodman, PhD
Editor, Journal of Abnormal Psychology
Department of Psychology
Emory University
36 Eagle Row
Atlanta, GA 30322

General correspondence may be directed to the Editor's Office.

In addition to postal addresses and telephone numbers, please supply electronic mail addresses and fax numbers, if available, for potential use by the editorial and production offices.

Masked Reviews

Masked reviews are optional and must be specifically requested in the cover letter accompanying the submission. For masked reviews, the manuscript must include a separate title page with the authors' names and affiliations, and these ought not to appear anywhere else in the manuscript.

Footnotes that identify the authors must be typed on a separate page.

Make every effort to see that the manuscript itself contains no clues to authors' identities.

Types of Articles

Most of the articles published in the Journal of Abnormal Psychology® are reports of original research, but other types of articles are acceptable.

- Short Reports of replications or of failures to replicate previously reported results are given serious consideration.
- Comments on articles published in the journal are also considered.
- Case Studies from either a clinical setting or a laboratory will be considered if they raise or illustrate important questions that go beyond the single case and have heuristic value.
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The Journal of Abnormal Psychology publishes articles on basic research and theory in the broad field of abnormal behavior, its determinants, and its correlates.

The following general topics fall within its area of major focus:

- psychopathology - its etiology, development, symptomatology, and course
- normal processes in abnormal individuals
- pathological or atypical features of the behavior of normal persons
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- sociocultural effects on pathological processes, including the influence of gender and ethnicity
- tests of hypotheses from psychological theories that relate to abnormal behavior

Thus, studies of patient populations, analyses of abnormal behavior and motivation in terms of modern behavior theories, case histories, and theoretical papers of scholarly substance on deviant personality and emotional abnormality would all fall within the boundaries of the journal's interests.

Each article should represent a significant addition to knowledge and understanding of abnormal behavior in its etiology, development, or description.

In order to improve the use of journal resources, it has been agreed by the two Editors concerned that the Journal of Abnormal Psychology will not consider articles dealing with diagnosis or treatment of abnormal behavior, Journal and the of Consulting and Clinical Psychology will not consider articles dealing with the etiology or descriptive pathology of abnormal behavior.

Therefore, a study that focuses primarily on treatment efficacy should be submitted to the Journal of Consulting and Clinical Psychology. However, a longitudinal study focusing on developmental influences or origins of abnormal behavior should be submitted to the Journal of Abnormal Psychology**.**

Articles of five different types will be considered for publication in the Journal: Brief Reports, Regular Articles, Extended Articles, Case Studies, and Commentaries.

- Brief Reports must not exceed 5,000 words in overall length. This limit includes all aspects of the manuscript (title page, abstract, text, references, tables, author notes and footnotes, appendices, figure captions) except figures. Brief Reports also may include a maximum of two figures. For Brief Reports, the length limits are exact and must be strictly followed.
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the normal length restrictions of a Regular Article. Typically, Extended Articles will report multiple experiments, multifaceted longitudinal studies, cross-disciplinary investigations, or studies that are extraordinarily complex in terms of methodology or analysis. Any submission that exceeds a total of 12,000 words in length automatically will be considered for publication as an Extended Article.

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All cover letters must contain the following:

- the full postal and e-mail address of the corresponding author;
- the complete telephone and fax numbers of the same;
- the proposed category under which the manuscript was submitted;
- a statement that the authors complied with APA ethical standards in the treatment of their participants and that the work was approved by the relevant Institutional Review Board(s);
- that the material is original – if findings from the dataset have been previously published or are in other submitted articles, the distinctiveness of the submitted manuscript needs to be detailed and, if a reanalysis of data, a justification provided;
- whether or not the manuscript has been or is posted on a web site;
- that APA style (Publication Manual, 6th edition) has been followed;
- the disclosure of any conflicts of interest with regard to the submitted work;
- a request for masked review, if desired, along with a statement ensuring that the manuscript was prepared in accordance with the guidelines above.

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