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Attentional Bias Modification: Single Session Effects on Behavioural and Neurological Measures with High and Low Self-Esteem

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University of Huddersfield

Masters by Research

Psychology

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iii Abstract

The central idea of Attentional Bias Modification (ABM) has been that it can directly alter attentional biases by the use of computerized training procedures. Although ABM has advanced theoretically and methodologically in recent research, its clinical efficacy has been mixed. However the current study argues the strong potential for ABM to contribute as a psychological intervention, to the reduction of the formation of negative attentional biases. As contemporary models of depression and current literature reviews have emphasised the role of low self-esteem (SE) in the aetiology of depressive disorders, the current study investigated the causal role of SE on ABM efficacy. An independent groups design investigated behavioural and neurological differences in response to affective words based on participants Rosenberg Self-Esteem (RSES) scores. Forty participants (28 female) from a non-clinical sample completed a standard or ABM dot-probe task with 200 negative-neutral affective word pairs shown. Later, 10 words of both valence were memorised. Lastly, a delayed free recall task required participants to recall the 20 words. Event Related Potentials (ERP's) were recorded using a 256 channel dense-array electroencephalogram (EEG) in three separate pre-defined regions of interest, across the 200-280, 320-400, and 600-900ms epochs. Response times and word recall data were also gathered. In the three regions of interest, amplitude was not significantly different between the 2 SE groups, when in different dot-probe conditions. Therefore no interaction effect of SE and dot-probe condition was found. However in the prefrontal line, the dot-probe task had a significant main effect on amplitude, this was reflected by an increased presence of the N2 ERP potential as the negative stimuli caused greater conflict of expectations in attentional deployment. There was also a significant effect of time and SE on amplitude, which reflected initial modulations from the stimuli viewed as positive amplitudes in the first epoch, but decreased amplitude as the modulation from stimuli reduced. In relation to behaviour results, there were no significant differences in the number of words recalled, or response bias between groups, in terms of negative word valence. Overall the results did not support the underlying assumptions of the ABM paradigm, however two potential factors were unaccounted for, being the effects of individual amounts of attentional control, and the large regional distribution that processes of SE are diversely performed in. Both past and future research which fail to successful apply a single session ABM dot probe task can discount self-esteem as a potential moderator.

Keywords: Attentional Bias Modification, ABM, self-esteem, EEG, memory, dot-probe task

1 Literature Review

1.1 Theories of Attentional Bias

Identified as the disrupted control of attention, an Attentional Bias (AB) has been describe as the cognitive occurrence whereby an individual would have significant difficulty in disengaging from varying forms of negative or positive affective information presented (Cisler & Koster, 2010). In the formation of an AB, there are two types of attentional processing mechanisms which have been theorised to influence an individual’s cognitive appraisal of emotional stimuli to produce biases in their attention (Todd et al., 2012). These mechanisms have been called top-down and bottom-up attentional processing.

Top-down control of attention also known as goal-driven attentional processing, has been described as the ability to voluntarily attend to select pieces of information within the environment (Serences et al., 2005). Top-down control of attention has been theorised to have the ability to apply an AB towards an object’s features that have been predefined by an individual’s unique ‘Attentional Control Setting’ (Folk, Remington, & Johnston, 1992). This attentional control setting consists of mental templates (Todd, Cunningham, Anderson, & Thompson, 2012) which can be used to enhance the individual’s ability to filter unnecessary objects. The attentional adjustment can facilitate a faster deployment of attention towards a specific object in the environment, for example searching for an affective picture amongst several others. An AB towards affective information has been argued to be an output of a top-down affective tuning of the ‘Attentional Control Settings’, which implicitly and proactively shapes an individual’s perpetual experience (Todd et al., 2012).

In contrast bottom-up, also known as stimulus-driven, processing of attention has been described as the individual's ability to have their attention captured involuntarily by significant alternative emotional stimuli within the same environment. Bottom-up processing of attention has been suggested to be reflexive and immediate in attentional deployment (Todd et al., 2012). The selection process is based upon low-level or very basic features of particular stimuli such as valence, shape, and motion (Hou & Zhang, 2007; Todd et al., 2012). Bottom-up processing holds the ability to override top-down processing due to the fundamental nature of human neural attentional construct. To explain this point, Ekman (1999) described prioritization towards protruding exogenous stimuli may have been due to human emotional capability being founded on neural circuits that are evolutionarily orientated, which respond rapidly to threatening or important events. Therefore, an AB towards negative stimuli, specifically self-relevant or threatening stimuli could be a defence mechanism based upon perceived threat in the environment.

In pragmatic descriptions, an AB towards negative stimuli can be formed when individuals have a maladaptive tendency to attend to negative, self-referent, or threatening information (Paulewicz, Blaut & Klosowska, 2012). Originally associated with anxiety, a negative AB has increasingly been incorporated to the psychopathology of depression (Bradley, Mogg, & Lee, 1997; Donaldson, Lam, & Mathews, 2007) and has been suggested to be a cognitive mechanism underlying a wide variety of clinical conditions (Mogoase, David, & Koster, 2014). It has been identified in the attribution of visual attention when presented with negative words, and with faces of a negative expression (Leyman, De Raedt, Schacht, & Koster, 2007). Generally, negative attentional biases can occur in a variety of circumstances which results in critically influencing an individual’s cognitive processes for substantial temporal periods.

1.2 Extended Model of Emotional Regulation

A contemporary theory which developed from, and expanded upon the previously described models of attentional processing, has been called the Extended Model of Emotion Regulations (EMER; Todd et al., 2012). The EMER was a comprehensive model that integrated key theories in developmental psychology with cognitive and affective neuroscience, and considered the additional concept of affect-biased attention (Corbetta & Shulman, 2002). Affect-biased attention refers to the tuning of sensory attentional systems, which results in the preferential selection of affectively salient stimuli. It could be viewed as a top-down approach that can modulate emotional responses via its ability to predispose an individual’s perceptions. These perceptions can be towards stimuli with a specific valence, i.e. negative words or pictures, instead of those with more neutral or positive valence. From this, the EMER had posited that affect-biased attention can be a reflexive and habitual action implicitly performed before full awareness of the presented salient stimuli (see figure 1).

To develop this point, it proposed that an AB could be formed through a change in the individual’s selection process, through their history of experience in a given context. The EMER model described that an individual’s affective salience network can impact upon the visual system by prioritizing attention to motivationally relevant stimuli based on the past experiences with the specified emotional stimuli. Thus, certain information presented can then be selected with a predisposition for the individual to attend to. This would suggest susceptible individuals may be at greater risk of creating an AB towards stimuli of a specific valence. This model improved upon the limitations found in other models of emotional regulation, which instead viewed AB as a symptom of an individual’s bottom-up reactivity to an emotional response (Silvers et al., 2012). Instead, the EMER underlined the importance of the top-down regulatory role that affect-biased attention contributes prior to an emotional stimulus presentation. This model has helped to synthesise research in visual selective attention with clinical research as it has been able to extend and apply current theories in selective attention to individuals whom display significant atypical AB towards emotionally valenced stimuli.

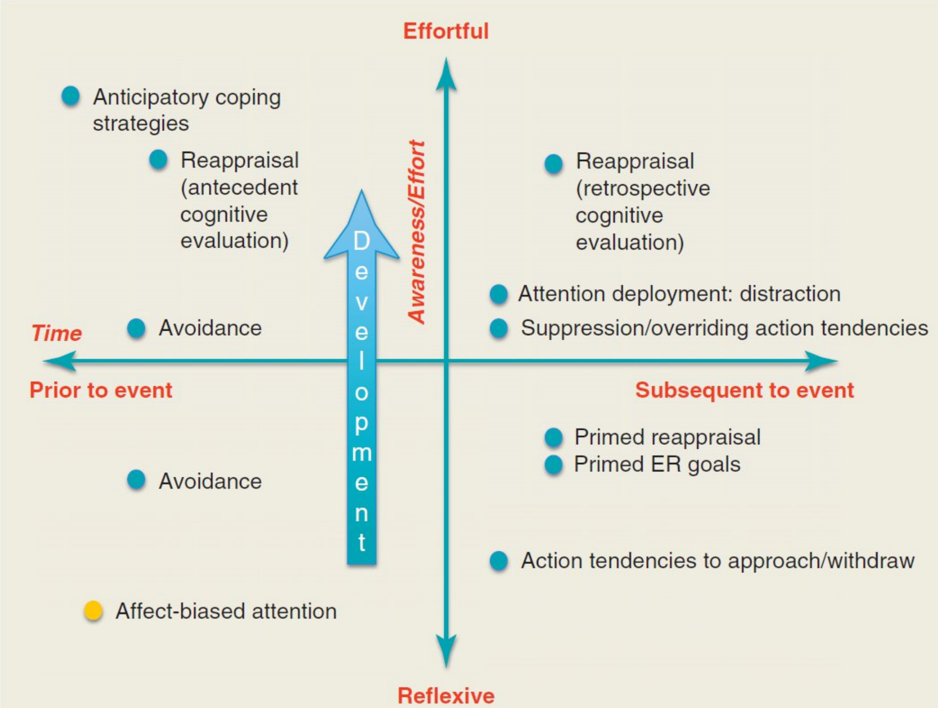


Figure 1: Extended model of emotional regulation, taken from Todd el at (2012). The x axis represents time prior to and subsequent to an emotionally arousing event (time 0) and the y axis represents the range of regulatory processes from habitual to effortful.

1.3 Negative Attentional Bias in Developing Clinical Symptoms

Contemporary studies have expressed the implications of AB with added emphasis on the functional effects. Peers, Simons, and Lawrence (2013) stated that an exaggerated bias towards innocuous information can be a key contributor in the aetiology, maintenance, and increase in a variety of mood and anxiety disorders. Williams, Mathews, and MacLeod (1996) had also previously suggested that an individual's habitual AB to negative stimuli can be a phenomenological mechanism which may unintentionally perpetuate several clinical disorders. These suggestions were based upon earlier cognitive theories of affective disorders which described how AB can be a risk factor towards the initiation and preservation of depression and anxiety (Clak & Beck, 1999) as AB has the ability to be a resilient intervening factor.

According to cognitive theories of depression (Beck, 2008; Beck, Beevers, Disner, & Haigh, 2011; Clak & Beck, 1999; Mathews & McLeod, 2005; Williams, Watts, MacLeod, & Mathews, 1997) its development and maintenance could be causally attributed to the role of negative attentional biases. Most recently, Yang, Qi, and Guan (2014) suggested these negative attentional biases could be associated with even greater risk of developing depression as their effects were previously underestimated.

Indeed, a plethora of studies have demonstrated depressed individuals deploy their attention with a bias towards negative stimuli (Disner, Beevers, Haigh, &Beck, 2011; Gotlib & Joormann, 2010; Kaiser et al., 2014; MacLeod, Rutherford, Campbell, Ebsworthy,& Holker, 2002; Otto&Peckham, 2010; Peckham, McHugh, & Otto, 2010). This also has been found in non-clinical individuals with different risk factors for the onset of depression (Joormann, Talbo, & Gotlib, 2007) effectively creating impaired attentional disengagement from negative stimuli. An influential study by MacLeod et al (2002) stated that when undergraduate participants were trained to attend to negative instead of neutral stimuli, the participants showed significant increases in depression related mood scores. This research displayed the possibility that attention can be altered towards negative stimuli, and a vulnerability regarding significantly increased negative affection is then created. Negative attentional bias therefore has been shown to be more than just a marker of mood, but as previously stated, possibly an early indication into rising malformations associated with depression.

1.4 Negative Attentional Bias in Developing Memory Bias

One possible malformation associated with depression which an AB towards negative stimuli can perpetuate, is memory bias (MB). The phenomenon of a MB (Blaney, 1986) has been stated to involve a mood congruent bias towards the recall of negatively or positively valenced stimuli. Although a MB towards negative information has been the most frequently occurring bias found within the literature (Blaut, Paulewicz, Szastok, Prochwicz, & Koster, 2013) a MB for positive stimuli can also occur, and in a variety of contexts. For example in certain circumstances high SE individuals have been shown to recall a significantly higher amount of positive material than those which are neutral or negative (Erber & Erber, 1994; Josephson, Singer, & Salovey, 1996; Parrott & Sabini, 1990; Rusting & DeHart, 2000).

However, a MB towards negative stimuli has been acknowledged within depressed and sub-clinically depressed individuals, as they illustrate a lack of positive recall when presented with a range of emotional material (Blaut et al., 2013; Breslow, Kocsis, & Belkin, 1981; Denny & Hunt, 1992; Mathews & Bradley, 1983; McDowall, 1984). For example, Everaert, Duyck, and Koster (2014) described sub-clinically depressed individuals recalled more negative words from previously viewed sentences, which suggested a dependence of memory on depression-related processes of interpretation and attention. Similar results were established by Ellis, Beevers, and Wells (2011) as dysphoric participants presented with only positive and negative words, did not recall many positive words. This resulted in significantly less accurate recognition of positive words presented in a later memory task within the dysphoric group, instead a significantly increased recognition for negative words was shown. A control group within this study provided results which supported the notion that a MB towards negative information does not occur in non-clinical individuals, whom are able to recall information without a bias towards a stimuli of specific valence.

Studies that have investigated the correlations between attentional and memory biases suggested that an AB towards negative stimuli correlates with an increase in recall of negative words in later memory tasks (Koster, De Raedt, Leyman, & De Lissnyder, 2010). One of the earliest studies to investigate the mutual dependence of attention and memory was by Pratto and John (1991). Presented in a stroop task, they asked 16 participants to name the colours of adjectives with differing valence from 1 (extremely undesirable) to 9 (extremely desirable). Participant were slower to respond when viewing negative adjectives compared to positive adjectives, and in a later word recall task 85% of participants recalled a higher amount of undesirable words than desirable. They suggested that individuals misperceive stimuli within their environment as threatening, with attention disproportionately directed to these perceived negative stimuli.

Furthermore, Koster et al (2010) used a spatial cueing task whereby participants deployed attention to negative or positive stimuli within the task, allowing for elaboration. Consequently, they recalled a significant amount of the same negative stimuli in an additional recall task, which the prior spatial cuing task comprised of. Additionally, non-depressed and sub-clinically depressed participants in a study by Ellis, Beevers, and Wells (2011) attended to negative, neutral, or positive words as measured by eye tracking technology. Their eye movements were free to roam over the depression related stimuli, which meant their scanning was exclusively dependent on any attentional biases present. In a subsequent recognition task, previous words presented were recognised significantly less if they were positively valenced, in the experimental condition compared to the control condition. This absence in AB in regards to positive stimuli has been shown to be typical for individuals with subclinical depression (Everaert et al., 2014; Ishii, Sugimoto, and Katayama, 2012; Denny & Hunt, 1992). Previous research meta-analysed by Matt, Vazquez, and Campbell (1992) also described this phenomenon.

The link between an AB and the formation of a bias in memory can be explained by the combined cognitive bias hypothesis (CCBH; Everaert et al., 2014). The CCBH has theorised that there is interplay between maladaptive interactions, with their combinative effects cyclically influencing subsequent memory processes. The combined effects of attentional, memory, and interpretational biases are theorised to have a greater effect in comparison to the effects produced if the biases were independently deployed. Research into the psychopathology of depression has viewed the contributing factors of cognitive processing biases (biases in attention, interpretation, and memory) to be dissimilar and assumed separate entities because of their apparent differences. This approach has helped to reveal the dynamics and underlying functions within a singular bias. However, exploring the role of one cognitive processing bias lacks the prerequisite necessary for a more in-depth and functional psychopathological analysis. Only recently have researchers considered that these factors have significant links between themselves, with an expanding number of studies concur that this approach should be integrated in future research (Hertel & Brozovich, 2010; Hirsch, Clark, & Mathews, 2006). By addressing the methodology in past studies, a seminal study by Blaut et al (2013) directly assessed the causal relation between attention and memory bias. In the 71 undergraduate students with elevated depression scores, 34 in the experimental condition reportedly trained their attention away from the negative words presented therefore they did not display a MB in a later word recall task. The majority of the 37 participants in the control condition displayed an AB towards negative words, as shown by the behavioural measure of an increase in negative words recalled.

From this, contemporary studies have investigated the interdependence between attention and memory (Ellis, Wells, Vanderlind, & Beevers, 2014; Everaert et al, 2014; Everaert, Tierens, Uzieblo, and Koster, 2013). These studies provide similar results in suggesting that each cognitive process has a causal effect on the next process; AB effects interpretation, and interpretation effects memory. AB can then cyclically increase an individual’s vulnerability to attend to the initial emotional stimuli, as suggested by the EMER theory of attention.

1.5 Dot-Probe Task

From the mentioned literature review, it could be suggested that the causal relation between an AB and depressive symptomology can be a vulnerability factor for the formation and intensification of more symptoms, for example in the development of a memory bias towards negative stimuli. To prevent this occurrence, contemporary studies have reduced negative attentional biases by use of a modified version of the dot-probe task (MacLeod, Mathews, & Tata, 1986).

The dot-probe task was developed to measure attention to threatening stimuli. Commonly, a centrally presented fixation point ('+') appears for 500 milliseconds (ms) and denotes the start of each trial (Koster, Crombez, Verschuere, & De Houwer, 2004). After, the cross would disappear and a neutral-negative word pair would be presented. This was typically for around 500 milliseconds (ms) (Miskovic & Schmidt, 2012) however the stimulus presentation time can be changed in accordance with the aims of the experiment. Both words would be equidistant from the centre of the screen, and could be horizontally or vertically aligned. After this, the word pair disappears and a probe, typically an asterisk (*), appeared either in the negative (congruent) or neutral (incongruent) position where one of the previous words was located (Yiend, 2010). The symbol used is typically an asterisk, however this could change depending on what the task was set out to measure, i.e. a probe location task or a probe identification task (see Salemink, van den Hout, & Kindt, 2007). Participants would be instructed to indicate the spatial location of the probe, by pressing the assigned response on the input equipment provided (i.e. on a keyboard press key '1' for a congruent location, and key '0' for an incongruent location). Attentional biases are inferred in any version of this task by being scored. Scoring involves subtracting the mean reaction time for the probe in the congruent position with mean reaction times for the probe in the incongruent position. Significant differences occur in response latencies towards a probe which replaces threatening stimuli, compared to a probe replacing neutral stimuli. Theoretically, the threatening stimuli would have captured an increased amount of attention in the spatial location occupied by the stimuli, regarded as threatening towards the participant i.e. the word 'failure'. Therefore participants attention would already have been in the spatial location of the probe when it appeared, reducing their response time.

1.5.1 Attentional Bias Modification

In this modified version of the original dot probe task, ABM was specifically implemented to reduce the influences of negative attentional biases (Mogoase et al, 2014). ABM tasks have controlled exposure time to stimuli and can be used to observe the time course of attentional biases with a range of information presented (Staugaard, 2009; Scmukle, 2005). The central idea of ABM was that it directly altered biases by the use of computerized training procedures (Vrijsen et al., 2013), this notion was first underlined in several earlier studies (MacLeod, Koster, & Fox, 2009; Matthews and MacLeod, 2005). In comparison to standard dot-probe procedures a probe appears either significantly less, or not at all, in the negative stimuli position than in the neutral stimuli position. The underlying assumption is that visual orientation is trained away from the negative stimuli, which should reduce the preferential attentional processing towards negative stimuli. The dot probe task has demonstrated that in its ABM adaptation, participants alter their attention with concordance towards the prescribed contingency (MacLeod et al., 2002). Additional recent studies have shown this contingency as attentional bias scores were also found to be significantly reduced in the ABM training conditions in comparison to standard dot-probe tasks (Beard, Sawyer,& Hofmann, 2012; Hakamata et al., 2010; Mogoase et al., 2014).

Due to its ease of application, and utility in assessing and manipulating attention to stimuli, ABM has been included in a wide variety of applications, including the modification of dysfunctional and functional approach avoidance tendencies (Rinck et al., 2013; Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011) andthe effects on post-traumatic stress disorder (Schoorl, Putman, & van der Does, 2013; Woud, Holmes, Postma, Dalgleish, & Mackintosh, 2012). With emotional disorders, ABM has had evidence to suggest effectiveness in participants with anxiety (Abend, Pine, Fox, & Bar-Haim, 2014; Heeren, DeRaedt, and Koster, 2013; MacLeod et al., 2009; Hakamata et al., 2010; Eldar & Bar-Haim, 2010), and is already marketed to individuals with a range of anxiety levels. It is becoming frequently used with depressed individuals (Ellis et al., 2014; Vrijsen et al., 2013) with research starting to delve into the neural mechanisms and trajectories of change during ABM application with clinical individuals (Beadel, Smyth, & Teachman, 2014; Britton et al., 2014). Currently, the application of ABM with memory biases hasbegun to receive increased amount of interest (Blaut et al, 2013; Hertel & Mathews, 2011; Vrijsen et al., 2013) to add to the vast range of applied ABM research.

1.5.2 ABM and Depressive Symptom Reduction

Within the limited number of studies in depressive symptom reduction, there have been reports of successful application. Wells and Beevers (2010) stated ABM was able to reduce depressive symptoms in undergraduate students with mild to moderate depression scores. They presented dysphoric participants with neutral stimuli in a modified dot-probe task over 4 training session. The results suggested the ABM condition significantly reduced AB towards the negative stimuli with less depression symptoms reported afterwards. The most important finding in their study was that a reduction in depressive levels between the dot-probe conditions was mediated by improvements in AB away from negative stimuli. This suggested that the further development of depressive symptoms could be hindered by ABM in individuals with an increases vulnerability to negative stimuli, as described in the CCBH theory. Additionally, Browning, Holmes, Charles, Cowen, and Harmer (2012) separated remitted depressed patients into ABM or standard dot-probe groups, using positive/negative faces or words as the valenced stimuli. After 28 sessions over a two week period, participants were again measured on AB and depressive symptoms. The results showed there was a significant decrease in both AB towards negative stimuli (face stimuli only), and a decrease in residual depressive symptoms.

These studies aligned with the majority of results that have shown successful ABM application, they have similarly suggested that not only were clinically relevant symptoms reduced but ABM has had an additional positive effect on participant’s response to subsequent stressors (Vrijsen et al., 2014). This means that ABM has been able to help reduce negative AB, and has shown to be excellent in reducing vulnerability to stress in post-ABM sessions (De Voogd, Wiers, Prins, & Salemink, 2014; Hallion & Ruscio, 2011). Therefore, if attention can be shifted away from negative stimuli it can effectively reduce the deployment of attention towards other similar stimuli. This would have the potential to create benefits for both cognition and social interaction, with the individual being more resilient to the effects of receiving negative information.

1.5.3 Unsuccessful ABM applications

Conversely, there are several studies that contradict this suggestion. Osinsky, Wilisz, Kim, Karl, and Hewig (2014) applied either a standard or ABM single-session dot-probe technique to 58 participants (30 in the control condition). The materials used were 480 face pairs, each pair consisted of two expressions of the same person: angry or neutral. As indexed by the N2pc and as they predicted, the results showed a difference in the neurological components between the two face expressions. This suggested threatening faces automatically drew attention in early stimuli processing compared to neutral expressions.

However, when comparing ABM with the standard dot-probe task, no significant electrophysiological changes were displayed. Additionally, there were no reaction time based attentional bias index reductions, suggesting no change at a behavioural level either. This is similar to results from Baert, De Raedt, Schact, and Koster (2010) as no significant training effect were shown in dysphoric and depressed individuals when using an ABM task displaying negative, positive, or neutral words. Only mild improvements in depressive symptoms were displayed in the mild dysphoric participants and overall the study failed to show any training effects of attention. These findings are in line with a number of similar studies which also did not replicate successful dot-probe ABM delivery (Roberts, Hart, & Eastwood, 2010; Julian, Beard, Schmidt, Powers, & Smits, 2012; Rapee et al., 2013).

One suggestion by Osinsky et al (2014) for this opposition in findings in ABM efficacy may be that ABM itself has no impact on early automatic mechanisms of attentional processing and presentation times need to be longer for participants to be able to elaborate on the stimuli. This means ABM may be more suited to later processes of more conscious emotion regulation when presented with affective stimuli.

1.5.4 Stimulus presentation times

However, the previously mentioned unsuccessful studies all used stimulus presentation times which have been shown to facilitate both early and late attentional mechanisms therefore can have an effect on participants’ attentional processes. Many studies including Osinsky et al (2014) and Rapee et al (2013) use a minimal stimulus presentation time of 500ms.This presentation time is typical in dot-probe usage and it has allowed for development of attention past the initial automatic attentional shift, as it is the start of an individual's evaluative categorization stage (Ito, Larsen, Smith, & Cacioppo, 1998). In a similar description it is stated to be the minimal time to differentiate between the processes involved in initial attentional orientation and the maintenance of selective attention (Mogg, Philippot, & Bradley, 2004). Therefore as suggested by other studies successful in ABM application which also used a minimum of 500ms stimulus presentation time (Atchley, Ilardi, & Enloe, 2003; Atchley, Stringer, Mathias, Ilardi, & Minatrea, 2007) it does provide the ability to impact upon the early processes of attention and can be established it would not have been an influence on the efficacy of ABM.

1.5.5 Inconsistent ABM Efficacy Regarding Symptom Levels

Indeed, Baert et al (2010) specifically optimised their stimulus presentation time (1500ms) and methodology to fit with the contingency of both depressed and healthy participants involved (see 2.2.6 *Stimulus Presentation Time* for expansion of this point) yet no significant improvements were found. They concluded that the efficacy of ABM may depend on depression severity, with stronger effects on non-clinical individuals with mild symptoms. Again however, ABM has shown to work for participants with a range of symptom severity no just a select band, yet there has been no obvious assertion for this inconsistency. One explanation for this mix in results may not be due to the measured emotion specifically, or the implementation of ABM itself, but a possible unmeasured confounding element within the participants.

1.5.6 Mechanisms in ABM

For the further investigation of this notion, it would be necessary to label a factor which may have been influencing participants' cognitive processes in previous studies, yet has not been assessed and can be linked to the affective states of previous interest. Once this factor has been identified, further research would be required to understand the behavioural and neurological mechanisms with which this factor affects the efficacy ABM, in order to manipulate and alleviate those effects. This would help to decipher why ABM has inconsistencies in its success.In agreement, Osinsky et al (2014) stated the neurocognitive changes during ABM on the processes of attention have had little understanding. Research into the neural mechanisms and trajectories of change during ABM application (Beadel et al., 2014; Briton et al., 2014) could be useful in illustrating how it is able to neurologically manoeuvre the individual, which could also highlight possible individual factors that may be preventing the maximal benefits of ABM in certain individuals. If future studies are able to identify the neurocognitive modifications which ABM deploys, and reasons for its limitations, its development could be steered in the right direction.

1.6 Depression and Self-Esteem

One possible confounding variable in the efficacy of ABM may be self-esteem (SE). Depression and SE have a strong negative correlation (Sowislo & Orth, 2013), and a growing body of both short-term and longitudinal research suggest that low SE prospectively predicts depression (Kernis, Greenier, Herlocker, Whisenhunt, & Abend, 1997; Orth, Robins, & Meier, 2009; Orth, Robins, & Roberts, 2008; Roberts & Monroe, 1992). Contemporary models of depression and current literature reviews also emphasise the role of low SE in the aetiology of depressive disorders (Evraire & Dozois, 2011; Hammen, 2005). For example, Cheng and Furnham (2003) state SE is a proximal vulnerability factor to depression, and has been understood to be a strong predictor of depression in adolescents (Kernis, 2003). A longitudinal study by Orth et al (2008) suggested that among young adults, low SE predicted consequent depression levels and social isolation, but that depression did not predict low SE later in life. This was supported by Wood, Heimpel, Manwell, and Whittington (2009) as they also observed the unidirectional occurrence whereby low SE individuals tended to dampen positive effect in contrast to high SE individuals, and were more likely to be undeserving of positive outcomes. This has been suggested to be a potential contributor towards the development of depression. Although there has been many studies that have investigated attention and memory biases in individuals with depression or anxiety (Dalgleish and Watts, 1990; MacLeod, Mathews & Tata, 1986; Koster, De Raedt, Leyman & De Lissnyder, 2010), to the awareness of the researcher there have not been any studies considering the role of SE in the efficacy of ABM.

1.6.1 Self-Esteem

Defined as the evaluation of oneself, SE is an individual's emotional self-acceptance and rejection status (Zeigler-Hill, Li, Luo, & Zhang, 2012). More specifically, it is the outcome of evaluating the self, with an attitudinal disposition that influences both behaviour and mood (Baldwin & Hoffman, 2002). SE is amongst other self-concepts of self-efficacy, self-knowledge, and self- awareness; however SE signifies how an individual subjectively feels about various aspects of their self and is different from the other components which are included in an individual’s self-concept. SE has a varied and heterogeneous description as it has been theorised to possess different forms, each with varying origins. Implicit and explicit SE (Greenwald & Banaji, 1995; Karpinski, 2004), contingent SE (Cambron, Acitelli, & Pettit, 2009), and global or specific SE (Rosenberg, Schooler, Schoenbach, & Rosenberg., 1995) are the different types of SE which are frequently researched.

If disproportionate levels occur, SE has been suggested to have significant neurological and behavioural effects on a wide range of tasks. Such tasks have included social acceptance (Rossignol, Campanella, Bissot, & Philippot, 2013), evaluation of environmental threats, perceptions in mathematical tasks (Yang, Zhao, Zhang, & Pruessner, 2013), response to social rejection (Li et al., 2012), and enhanced susceptibility to emotional stimuli (Li & Yang, 2013). Specifically, low SE may be a vulnerability factor for depression alongside several other psychological disorders including anxiety, social phobia, and eating disorders.It has already been shown to have moderate associations with anxiety and phobias as well as other psychological disorders (Osinsky et al, 2014). As Fennel (2005) stated, low SE is a trans-diagnostic cognitive subject, which does not fit in within the diagnoses of traditional psychiatric classifications. This means that low SE can be effectively viewed as an aspect of, consequence of, or predisposed vulnerability towards a large variety of psychological difficulties. It is a vulnerability factor which not only compounds the difficulty, but may hinder treatments which can be applied to help address the individual’s primary psychological difficulty. In phenomenological and sociological terms this means that individuals may experience, perceive, and interpret ontologically different existential realities due to the formation and maintenance of a psychological disorder (Smith, Flowers, and Larkin, 2009) which may facilitate the formation of more severe psychological difficulties.

1.6.2 The Importance of Self–Esteem

A comprehensive volume of studies have shown the importance of acquiring adequate levels of SE. It has been shown in its ability to buffer individuals from negative experiences (Brown, 2010), anxiety (Pyszczynski et al., 1992), to buffer against stress (Baumeister, Campbell, Krueger, & Vohs, 2003), to cope when discrimination is received (Corning, 2002), and to maintain a higher capability for better psychological adjustment (Baumeister et al., 2003). Additionally, healthy levels of SE help to maintain lower negative, and heighten positive self-regard (Orth, Robins & Widaman, 2012), and spontaneously attribute attention to positive information which has shown to enabled the individual to uphold their levels of SE (DeWall et al., 2011). A plethora of research has indicated that varying levels of SE can also influence the individual's response to certain types of stimuli (Li & Yang, 2013; Zeigler- Hill, Li, Luo,& Zhang, 2012; Li et al., 2012; Richter & Ridout, 2011; Brown, 2010; Ishii et al., 2012). For example, early research by Leary et al (1995) established that low SE individuals deployed significant levels of attention to general rejection stimuli in early processing stages. Studies thereafter have also consistently established that significantly diminished levels of SE have similar effects on the individual (Li & Yang, 2013; Rossignol et al., 2013; Yang et al., 2013) in terms of attention to valence stimuli contingent to their SE. The extent of the different social and cognitive areas which low SE can affect the individual are still unknown.

1.6.3 Theoretical Models of Self-Esteem and Depression

Orth and Robins (2013) provided a thorough overview of the differing models suggesting the relation between low SE and depression. These models include the vulnerability, scar, and reciprocal models (*see* Orth & Robins, 2013). These models have been tested in several studies (Orth et al, 2008; Orth, Robins, Trzesniewski, Maes, & Schnitt, 2009; Shahar & Henrich, 2010). Most of the studies use advanced statistical approaches, and are based on cross lagged regression models - the most frequently used way to establish the prospective effect of one variable on another. All the described models gained weak support except one receiving strong and robust empirical support, being the vulnerability model (Roberts, Kassel, & Gotlib, 1996). The vulnerability model has suggested that when an individual negatively evaluates their self, this may constitute a risk factor for depression (Sowislo & Orth, 2013; Metalsky, Joiner, Hardin, & Abramson, 1993; Whisman & Kwon, 1993), opposing the perspective of the scar model. Furthermore, Orth and Robins (2013) state that a meta-analysis of 77 longitudinal studies indicate both the scar and vulnerability model showed a statistical significance, however the vulnerability effect was shown to be twice as large as scar effect (Sowislo & Orth, 2013). The vulnerability model has been found to be robust and holds over a wide range of studies and samples (Kuster, Orth, & Meier, 2012). The relation between SE and depression reportedly has not varied by sex, even though men and women differ in their average levels of SE and depression. The vulnerability effect holds across all age groups, starting from childhood ranging to old age (Sowislo & Orth, 2013), it has been shown to be robust for somatic and affective-cognitive symptoms of depression (Kuster, Orth, &Meier, 2012), with differing SE and depression measures (Sowislo & Orth, 2013), in addition has held across temporal intervals from a few weeks to over a decade (Sowislo & Orth, 2013; Steiger, Allemand, Robin, & and Fend, 2014).

Importantly, the vulnerability model additionally based SE and depression as two separate entities. Watson, Suls, and Haig (2002) argued that they stem from one source, and consequently they should be considered as two entities derived from a common constructs. However, empirical findings have suggested SE and depression should be distinguished from one another (Orth et al, 2008). The initial similarities in depression and SE may have been a factor as to why they were not measured separately in previous ABM studies, however seminal research by Orth et al (2008) displayed a better fit of data when analysing SE and depression within a two-factor model, than a singular common factor model. Furthermore, correlations across studies for depression and SE range between -.2 and -.7 (Sowislo & Orth, 2013) this suggested a significant variation not able to support the idea they are both from a singular, common construct. Therefore although comparable, they have digressions between themselves which highlights important underlying differences, as supported by the vulnerability model. This study adopted the theory that SE and depression are to be conceptualised, measured, and analysed individually.

1.7 Application of EEG

To reveal more about how the individual is affected by their SE, increasingly prevalent in contemporary research is the use neurological measures. This methodology was implemented as although previous research acknowledged that SE can affect individuals on various behavioural levels, the different attentional deployment strategies that both low and high SE individuals use have had little attention. Klackl, Jonas, and Kronbichler (2013) recommended that SE needed to be investigated further in relation to its mediating effects on attentional deployment, and how neurological responses are manipulated due to this occurrence.

One approach to investigate this field has been with use of an Electroencephalogram (EEG). An EEG can record and localize brain function. This has been achieved by placing a large amount of electrodes placed non-invasively on the head. Either 16, 32,64,128, or 256 electrodes are able to measure and amplify significant amounts of electrical field produced on a macroscopic scale, by dendritic electrical activity (Buzsaki, Anastassiou,& Koff, 2012). The extracellular ionic currents, caused by this dendritic electrical activity, are recorded by the electrodes and converted into graphical representations ready for analysis (Pfurtscheller & Lopes da Silva, 1999; Buzsaki et al., 2012).

Event Related Potentials (ERP's) can be analysed from this data and linked to the spatial location of the scalp in either a 10-10, or 10-20 electrode montage (*see* Jurcak, Tsuzuki, & Dan, 2007). ERP's represent a measure of neuronal responses evoked by a specific stimulus and are real-time measurements of small voltages (microvolts, µV) which are time locked to motor, sensory or cognitive events (Sur & Sinha, 2009). They are generated by large populations of pyramidal cortical neurons which are perpendicular to the cortical surface, and are parallel in alignment to each other (Luck, 2005). Enhanced ERP’s are evoked at various temporal instants by affectively salient stimuli which help prioritize attention in both rapid and extended forms towards the stimuli (Stocburger, Codispoti, Junghofer, & Hamm, 2007).ERP's provide a continuous measure of processing between the stimuli and a participant's response, therefore determining which experimental manipulations are affecting the different stages in an experiment. They provide more direct measures of attention-related cerebral processing (Mangun & Hillyard, 1995) and are therefore an excellent means of directly investigating attention to stimuli and any response biases which occur from the stimuli presented.

ERP’s have been used in both internal and external environmental settings, to study both general and specific aspects of an individual's response (Klackl, Jonas, & Kronbichler, 2013). ERP's have a very fine temporal resolution (typically 2ms) which can reveal changes in the pattern of brain activity. ERP waveforms are described in terms of polarity and latency. Negative or positive polarity can be indicated by the sequence by which the peak occurs. Latency is an additional measure; the negative and positive peaks are measured from the time of either response or stimulus onset, i.e. a P2 component has a positive polarity, with a peak at 200ms after onset. Amplitudes of ERP components are generally assumed to signify the degree or intensity of the engagement of cognitive processes, and latencies are thought to measure the time course of cognitive processing (Luck, Woodman, & Vogel, 2000).

1.7.1 Self-Esteem and EEG Findings

As previously mentioned, although AB has predominately been studied within clinically depressed or anxious individuals contemporary research using EEG equipment performed by Ishii, Sugimoto, and Katayama (2012) studied individuals with varying levels of SE. They were one of the first to examine ERP's in young adults regarding the relationship between SE and an AB towards negative information. The study revealed that individuals with high SE were more likely to detect an inconsistency between their general positive feelings and beliefs, and the negative information presented. They analysed EEG recordings to suggest that in their daily cognitive processing, high SE individuals tended to attune automatically to stimuli with a significant increase in positive emotional valence. This was indicated by a significant increase in the N2 ERP potential at Fz, Cz, and Pz sites (see section *3.2 Analysis* for description of sites). The N2 potential has a latency of 200 milliseconds (ms) after the stimulus presentation and has a negative polarity. It has been suggested to show the allocation of visual spatial attention and has been shown to be a mismatch detector (Jurcak et al, 2007). The N2 potential was larger in response to negative compared to positive information, suggesting that high SE participants were less used to deflecting negative information. Summarized, the higher the SE of the individual, the greater the increase in activation of the N2 component when presented with conflicting emotional information. As mentioned, the EMER theory has suggested that the attention of high SE individuals can be predisposed towards stimuli which are in correspondence with their perceived SE level.

With opposing SE levels, participants involved in a study by Klackl, Jonas, and Kronbichler (2013) directed an increased amount of attention towards death-related words, in comparison to negative or neutral words presented. This resulted in an increase in the late positive potential (LPP) in the occipital and parietal sites, which is thought to reflect a long lasting and sustained increase in the processing and deployment of attention (Schupp, Junghofer, Weike, & Hamm, 2004). They also suggested that the mediating factors that SE possesses should be studied further in an attempt to uncover how it can impact upon the electrophysiological processes of attention. This has the potential to help individuals improve their attentional control, towards being a protective resource, or a buffer, in reducing apparent vulnerability to negative stimuli.

Based upon this, Li and Yang (2013) further investigated the ERP activities in individuals with low and high SE. They measured the time course of attentional deployment when participants completed a visual probe task, with positive or negative faces briefly presented before the probe. The EEG results showed that the N1 and an associated P1 potential activity in parietal regions were significantly increased for both types of emotional facial expression presented, in low SE individuals only. Therefore, the findings suggested low SE may have been a mediating factor in the eliciting of greater mobilization of attentional resources towards both positive and negative facial stimuli. Similarly, Zeigler-Hill et al (2012) investigated the ERP response to social rejection cues with low and high SE individuals in an attention shifting task. They similarly concluded that more attentional resources were allocated to negative cues in low SE individuals than those with high

SE. This exaggerated physiological negative stimuli response has been suggested by several similar studies (Gyurak & Ayduk, 2007; Somerville, 2010).

1.7.2 Limitations of Behavioural Measures

Despite the contemporary dates of research studying SE with EEG equipment, past research has limited use of 256-channel EEG equipment. Dense array EEG's, which support a 256-channel system, provides a distinct benefit over conventional moderate density EEG's of 32, 64, and 128 channel systems used in most previous studies (Ishii et al, 2012). In addition, with the exception of the above studies, most which have investigated the biases in attention deployment between individuals of differing SE have most often depended on behavioural indices to show differences, for example through response times. However, within the individual's earliest stages through to later decision making processes, their behaviour would have reflected a series of processes which are indirect indicators of attention, as inference would be required to link the attentional orientation with the behavioural measures displayed. In addition there is not an ability for behavioural measures of attention to reflect shifts in attention over a small time frame, instead only provides a general snapshot of the before and after deployment of attention (Horley, Williams, Gonsalvez, & Gordon, 2004; Li et al, 2012). With a dense array EEG, the brain's activities can be tracked in real-time and attentional, perceptual, cognitive, and motor functions can be separated in analysis. Additionally, ERP's allow the study of attentional biases that are not accompanied by reliable impairments in task performance at a behavioural level.

Dense array EEG has the highest temporal resolution amongst the non-invasive techniques which capture brain function. From this, an increased spatial resolution is formed and results in a more intuitive topographical view in comparison the ones produced by more limited equipment in the past. As there are ample scalp sites accessible, the recording of the brain's electrical field does not become distorted by spatial aliasing (Srinivasan, Tucker, & Murias, 1998) as opposed to lesser density systems. A large channel array of 256 electrodes allowed analysis to derive detailed topographical maps specific to each participant's brain activity at specified times, as well as a grand averaged map of activity. This allows the differences in ERP's between low and high SE individuals to be revealed and analysed in more detail than in previous research. From this, differences which are of interest to this study may be able to be modelled in a 2 and 3-dimensional format, to help locate the source of the ERP's of interest.

1.8 Hypotheses

Therefore, utilising contemporary EEG technology within the subject area of the above literature review, this study raised the following research aims:

Firstly for high and low SE individuals, to investigate how a single session ABM application can neurologically effect attentional deployment to negative stimuli, in comparison to a single session standard dot-probe application. Secondly, to investigate different electrophysiological processes occurring between high and low self-esteem individuals which may have significant affected the effectiveness of the ABM dot-probe paradigm, as suggested by ERP analysis and behavioural responses. Lastly, to assess the effects on the subsequent cognitive process of memory - theorised to have been affected by both self-esteem level and the dot-probe condition.

From the above, the following hypotheses can be constructed:

Words recalled:

1. There will be a significant decrease in negative words recalled by low SE participants in the ABM dot-probe condition compared to low SE participants in the standard dot-probe condition.

2. Within the ABM dot-probe condition, there will be a significant decrease in the amount of negative words recalled by low SE participants when compared to high SE participants.

Attentional bias scores:

3. There will be a significant increase in attentional bias scores away from negative stimuli, for low SE participants in the ABM condition compared to the standard dot-probe condition.

4. Within the ABM dot-probe condition, there will be a significant increase in attentional bias scores towards neutral stimuli for the low SE participants compared to high SE participants.

Neurological measures:

5. There will be a significant decrease in low SE participants' amplitude when responding to negative stimuli, for the ABM condition compared to the standard dot-probe condition.

6. Within the ABM condition, low SE participants will have significantly different amplitude in response to negative words, when compared to high SE participants, at all three time windows of interest.

2. Method

2.1 Participants

Twenty eight female (M*age* = 23.07, SD = 8.02, age range = 18-48) and 12 male (M*age* age = 24.68, SD = 7.63, age range = 19-46) students from the University of Huddersfield were recruited. The mean age of all participants was 23.55 (SD = 7.84). The age range was 30, from 18 to 48 years. They were recruited through either the psychology department's SONA system - a behavioural science experimental participation system, or volunteered via responding to flyers distributed in the psychology building. Those on the relevant psychology course and participated via SONA were given course credits. The majority of participants were 1st or 2nd year psychology students, with a minority of participants from different courses therefore different schools within the University. All participants were right handed. To be eligible, participants must not have had suffered from epilepsy or Attention Deficit Hyperactive Disorder, or had been on any anti-psychotic or anti-depressant medication. Also they must not have used non-permanent hair dye, as this would stain the EEG. They all had corrected to normal or normal vision. Participant's age, sex, Rosenberg Self-Esteem (RSES), Beck Depression Inventory-II scores (BDI-II), and EEG recordings were gathered. The mean RSES score for all participants was 21.52 (SD=4.18), and mean BDI=II score was 7.43 (SD= 6.77).

2.2 Apparatus and Materials

2.2.1 Rosenberg Self-Esteem Scale

The RSES (Rosenberg et al., 1995) is a self-report inventory consisting of 10 items rated on a 4-point Likert scale assessing current state global SE symptoms. Scores are from 0 to 3 and it has a scoring range from 0-30. A score of 0 is the lowest SE score possible and a score of 30 is the highest SE score possible. Questions 2, 5, 6, 8, and 9 are reversed scores. Previous studies may have used a 1-4 scoring system, these have been converted to a 0-3 scoring system where mentioned in this study. The RSES has been shown to have an uncomplicated language and excellent brevity as it can be completed in less than 5 minutes. Due to this ease of use and accessibility, the RSES has been translated into numerous languages, such as Chinese (Farruggia, Chen, Greenberger, Dmitrieva, & Macek, 2004) Dutch (Franck, De Raedt, Barbez, & Rosseel, 2008), Japanese (Mimura & Griffiths, 2007), Spanish (Martin-Albo, Nunez, Navarro, & Grijalvo, 2007), and Estonian (Pullmann & Allik, 2000).

Reliable and robust SE scales tend to measure global and domain-specific SE (Rosenberg et al., 1995). There are opposing conceptualisations which have viewed SE as either domain specific or generally applicable. Global SE has been theorised to affect the individual on a broad scale in various domains and is typically defined as an individual's overall sense of worthiness (Schmitt & Allik, 2005), whereas specific SE has been described as a concept whereby SE levels can affect specific singular entities within the individual (Swann& Bosson, 2010). Such domains include physical appearance, intellectual abilities or social interaction. There were several reasons why global SE had been measured instead of domain-specific SE for this study. Firstly, strongly related indicators of psychological adjustment, such as depression or anxiety, are comparatively global in their configuration (Swann, Chang-Schneider, & McClarty, 2007). This could be due to their combination of numerous cognitive, somatic and affective processes which collate to form a global rather that specific construct. Secondly, due to insufficient support for the validity of domain-specific measures of SE, global self-report measures such as the RSES are more typical measures used, additionally most theories comprise of global SE and psychological adjustment, not domain specific SE. This has corresponded with research which addresses global SE when investigating into psychological adjustments across a variety of domains. For example, Sowislo and Orth (2013) determined the degree to which global SE and domain-specific SE measures prospectively predict depression. They described that global SE drives vulnerability towards depression moreover domain-specific measures of SE. In addition, current literature suggests that an attentional bias towards negative information can develop in a wide variety of domains. Therefore, this study measured global SE with use of the RSES in an attempt to increase its applicability of findings to multiple areas where attentional and memory biases can transpire.

The RSES shows strong internal consistency and test-retest reliability (Blascovich & Tomaka, 1991; Sowislo & Orth, 2013), in both healthy and subclinical samples (Robins, Hendin, Trzesniewski, 2001), which also occurs with translated versions (Franck et al., 2008). It displays a transparent one-dimensional factor structure (see Schmitt & Allik, 2005) within all versions. It also shows thorough discriminant validity in reference to other measures, such as with academic outcomes, satisfaction in life, and short/long term optimism (Robins et al., 2001; Sowislo & Orth, 2013). This has helped to establish the relationships between concepts which may be unduly related to SE, and to establish construct validity when combined with its strength of convergent validity.

Additionally, the RSES is an explicit SE measure that has reliable findings of convergent validity with other measures of SE (Zeigler-Hill, 2010), such as with implicit SE (Bosson, Swann, & Pennebaker, 2000) at a range from .63 to .90. Explicit SE is defined as an individual's conscious feelings of self-liking, acceptance, and self-worth (Kernis, 2003), whereas an automatic self-evaluation has been typically believed to be implicit self-esteem (Pelham & Hetts, 1999).Explicit measures have advantages over implicit measures of SE as the benefits of implicit measures are outweighed by issues with their reliability and convergence validity with other global SE measures (Krizan & Suls, 2009). Recently, in current implicit tests Buhrmester, Blanton, and Swann (2011) suggested that rather than SE, generalized implicit egotism and implicit affect are being measured. For this reason in addition to those previously mentioned, the RSES was chosen to measure participants SE in this study.

2.2.2 Categorisation of Self-Esteem

Reviewing studies investigating opposing SE levels, it was important to consider how research has categorised SE into high and low groups. Previous studies have categorised SE by simply dividing scores into two. For example, Grundy, Benarroch, Lebarr, and Shedden (2014) categorised the two SE groups by scoring the top half of participants above the median number of 20 as high SE individuals, and those below the median of 20, as low SE participants.

This method had a limitation previously described by Li et al (2012) - that commonly used in studies are mean SE scores that have been low in comparison to other participants, but only moderate in an absolute sense. The RSES scores in several studies have been partitioned according to this methodology (Brown, 2010; Brown & Brown; 2011; Grundy et al 2014, Li & Yang, 2013) (see Table 1).A more appropriate way to categorise groups based on SE level would have been to take the range of SE scores and use the highest and lowest tertiles to categorise SE groups (i.e. SE scores ranging from 5 to 25 will have tertiles of 5-11, 12-18, and 19-25). This would ensure participants are at relatively opposing ends of the scale. They would be therefore more likely to have significant differences when compared to the method of referencing a median point, which may include participant with only 1 point difference of being in the opposing group.

Indeed this study intended to divide SE levels into tertiles of low (0-10), medium (11—20), and high (21-30) SE. However, the due to a limited number of participants in this study only 1 participant was in the low, 19 were in the medium, and 20 were in the high SE tertiles. This may have also been the reason why previous studies have used the median division method. A different design able to screen more individuals for SE levels, i.e. mass email with a link to the RSES, may have solved this issue as more participants may have been able to be included in the 0-10 SE range. Therefore this study categorised SE similarly to previous studies by use of a median cut off point. Participants with an RSES score of 20 or below were referred to as the low SE group (M=18.4, SD=3), and RSES score of 21 or above constitutes the high SE group (M=24.65, SD=2.5). Statistical significances were found when comparing the SE groups in the studies in table 1 and was also found for the two groups in this study (see 4.3 Self-Esteem and Depression Scores) suggesting significant difference in SE via this median point categorization method.

Table 1: Mean and standard deviations for categorising self-esteem groups in relation to the RSES scores.

Study	Year	Low SE (mean/SD)	High SE (mean/SD)	Total RSES score (mean/SD)
Brown	2010	N/A	N/A	22.95/4.82
LI, Zeigler-Hill, Yang, Jia, Xiao, Luo, and Zhang	2012	12.62 / 2.43,	21.08 / 2.69	16.85/2.56
Li and Yang	2013	16.1 / 2.9,	24.5 / 2.4	20.7/5.2
Grundy, Benarroch, Lebarr, and Shedden	2014	15.9 / 2.6	26.3 / 3.2	21.1/2.9

2.2.3 Beck Depression Inventory-II

The Beck Depression Inventory- second edition (Beck, Steer, and Brown, 1996; BDI-II) is a 21-item self-administered inventory which can be used as a measure of depression intensity symptoms within adults and adolescents. The BDI-II has many versions including BDI-I, BDI-IA (amended), and BDI-FS (fast screen for medical patients). However, the BDI-II has been deemed as a significant revision of the original BDI-I and revised BDI-IA. It’s assessment of symptoms corresponds to the Diagnostics and Statistical Manual 5 (DSM-5; American Psychiatric Association, 2000), by omitting items linked to hypochondria, weight loss, body image, and working difficulty. It has also corresponded to the DSM-V criteria for diagnosing depressive disorders by including items measuring cognitive, affective, somatic, and vegetative symptoms of depression (Smarr & Keefer, 2011). The BDI-II has been shown to positively correlate with the Hamilton Depression

Rating Scale (Hamilton, 1960) with a Pearson’s r rank of 0.71 suggesting a moderate correlation. Beck, Steer, Ball, and Ranieri (1996) described the BDI-II to also have a high internal consistency of 0.91. Items are rated on a 4-point scale in the scoring system of 0-3. Sum scores range from 0 to 63. Final scores are obtained by addition of scores for each of the 21 questions.

The following severity levels have been suggested within the manual; scores between 0 and 10 are indicative of minimal depression; scores between 11 and 16 are indicative of reflecting depression at a mild level; scores between 17 and 20 indicative of borderline depression, 21-30 are indicative of moderate depression; with scores between 31 and 63 suggesting severe and extreme depression. For this study, participants were required to indicate which statement best describes their feelings within the past two weeks, with inclusion of the day they fill in the questionnaire. The BDI-II required approximately 5-10 minutes completing, and individuals aged 13 to 80 years of age are suggested to be able to use the form (Beck, Steer, &Brown, 1996).

2.2.4 The Dot-Probe vs. Emotional Stroop tasks

The two tasks which have been commonly used to research into the phenomenon of attentional biases to negatively valenced information are the emotional stroop or dot-probe tasks. In the stroop task two dimensions, being the word meaning and colour, are contained in a single stimulus. For example, the word "Death" would be presented in a blue colour. A significantly longer time to name the colour of the word infers an attentional bias towards that word, with the assumption that the valence of the word would have disrupted the ability to name colours (Donaldson et al., 2007). However, the stroop task may be ambiguous in its measure of selective attention. De Ruiter and Brosschot (1994) suggested cognitive avoidance is a potential alternative explanation for the results produced by the stroop task, additionally Mogg, Millar, and Bradley (2000) stated a lack of clarity regarding the stage to which colour-naming interference occurs. Inference may occur at the attentional input or response output stages. Bradley, Mogg and Lee (1997) stated the later dot probe tasks have greater suitability when in comparison to the stroop task (Matthews & Harley, 1996; Williams, Mathews, & McLeod, 1996) and earlier versions of the dot probe task (MacLeod, Mathews,& Tata, 1986). Therefore the dot-probe task was used over the stroop task in this study.

Specifically, both a standard and ABM dot-probe task was used in this study. The probe used in the standard dot probe task had an equal probability of being in either the congruent or incongruent position, inferring that no attentional training would have taken place. However, the ABM probe in this study had a specified programme. The first 70 trials had a 20% probability of the probe being in the negative stimuli position, the second 70 trials the probe had a 10% probability of being in the negative stimuli position, and a 5% probability in the final 60 trials. A centrally presented fixation point (‘+’) appeared for 1000ms and denoted the start of each trial. After, the cross disappeared and a neutral-negative word pair was presented for 1000ms. Both words were equidistant from the centre of the screen, and vertically aligned. A probe, being an asterisk (*), appeared either in the negative (congruent) or neutral (incongruent) position where one of the previous words was located (See Figure 2). Participants were instructed to indicate the spatial location of the probe, by pressing on a standard keyboard the key '1' for a congruent location, and key '0' for an incongruent location. The task did not progress until the participant responds. After response, the cross reappeared and the task repeated for until completion of 200 word pairs.

This dot-probe task used a top-bottom stimuli presentation layout in comparison to a left-right layout, as Beard et al (2012) and Hakamata et al (2010) meta-analysed previous ABM studies to suggest a top-bottom stimuli position during training was more effective with studies using this layout yielding higher effect size as a results (mean effect size for top-down word placement was 0.88 compared to 0.02 for left-right placement).

However, the perception of a word and its meaning can be affected due to its placement (Beard et al, 2012). For example positive valence words are congruent with more upper and left orientated spatial locations and negative valence words with lower and right spatial locations (Pecher, van Dantzig, Boot, Zanzolie, & Huber, 2010; Huchinson & Louwerse, 2010; 2013). To prevent word placement affecting the dot-probe task (more specifically the participants processing of the words) the words presented were randomised to ensure words of both valence groups were equally presented at both locations to counter balance any congruency with the words to their spatial positions.

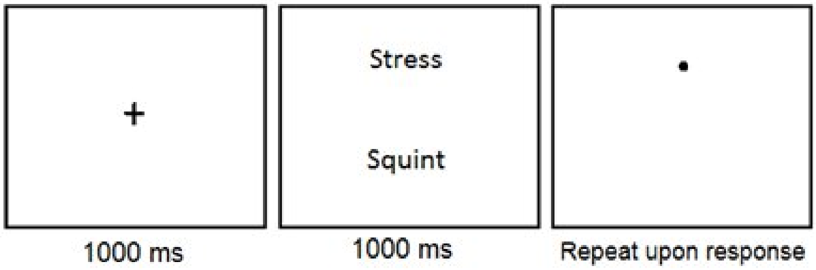


Figure 2: Three stages of the dot-probe task. A fixation point was followed by a neutral/negative word pair. A dot then replaced either the congruent or incongruent word until participant response.

2.2.5 Stimuli Used

Words were used as Hakamata et al (2010) suggested that attentional training has been more effective with verbal stimuli than with pictorial stimuli. In addition Beard et al(2012) stated in a meta-analysis of 37 studies, linguistic stimuli significantly moderated the effect of ABM, with words gaining a large effect size (effect size=0.91, CI(0.63, 1.18), p<0.001). The source of the words comes from Warriner, Kuperman, and Brysbaert (2013). They rated 13,516 words in terms of affective valence, i.e. pleasant to unpleasant, and arousal, i.e. calm to excited. Warriner et al (2013) based their work on the Affective Norms of Emotional Words (ANEW) collected by Bradley and Lang (1999). The ANEW was a set of normative emotional ratings for 1,034 words in the English language.

However, Warriner et al (2013) noted that research had repeatedly made use of the limited amount of words in the ANEW, and a richer source of information of emotional norms of words was necessary to effectively improve validity of the stimuli. Therefore 200 negative-neutral word pairs (400 words) were taken from the set produced by Warriner et al (2013) and included in this study’s dot-probe tasks. The rating scale ranges from 1 to 9, with 1 being the most negative rating given to a word, and 9 being the most positive. Words were chosen based on strength of emotional valence and sorted into a numerical order from the smallest valence (1.26; paedophile) to the highest valence (8.53; vacation). The range between 1 and 9 was divided into 3 groups; low, medium, and high valence. Low valence words were words rated between 1 and 3.66, medium valence words were rated between 3.67 and 6.33, and high valence words were rated between 6.34 and 9. The first 200 words from the start of both low and medium valence words were selected. This means that 200 words were used which have an increasing valence from 1.26 (1st word) to 2.58 (200th word). In addition, 200 words were used which have an increasing valence from 3.67 (201st) to 4.58 (400th word). The mean valence score for the low valence word list is 2.07. The mean valence score for the medium valence word list is 4.05, a difference of 1.98. The range of word length is from 3 to 12 letters, a difference of 9. The average word length was 7.54 letters. Word pairs were matched for word length.

2.2.6 Stimulus Presentation Time Selection

A methodological issue which needed to be taken into consideration within the dot-probe task was that an absence of its previous effect could be due to the possibility that the task measured a small snapshot of attention. The snapshot of attention is the moment in time where attention happens to be focused when the dot-probe appears. It was important to choose the correct stimulus presentation time which caters for the specific emotional disorder being investigated (Koster et al, 2004). If the stimulus presentation time was not long/short enough to support the variations in cognitive processing times with an attentional bias, then incorrect stimulus presentation times would not be able to capture the whole continuum of cognitive and attentional processes pertaining to a specified emotional disorder (Blaut et al, 2013; Mogg & Bradley, 2005).

To select the appropriate stimulus presentation time, the dual processing theory(Carver, Johnson, & Joorman,2008)was taken into consideration as it suggested attention is composed of a spontaneous yet inflexible information processing stream, and a more flexible, strategic and slower processing stream have been described. Depression has been hypothesised to be associated with abnormalities in this later processing stream. Furthermore, a 500ms stimulus presentation time has been successfully used with both words and faces in depressed and sub-clinically depressed individuals (see *1.5.4 Stimulus Presentation Time*) suggesting 500ms is the time to use in the current study. However with inclusion of eye tracking studies (Caseras, Garner, Bradley, & Mogg, 2007) it was suggested that an even longer stimulus presentation time can be associated with a longer gaze duration, or difficulty in disengagement from negative stimuli (Johnson, LeHuquet, Sears, & Thomas, 2010). Therefore, a 1000ms stimulus presentation time was used in this study for both dot-probe tasks as it provides the opportunity for both initial and sustained attention to stimuli for individuals with low SE and depressive symptoms.

2.2.7 The Memory Task

To assess the effects of the ABM training procedure, a set of words was presented to the participants 5 minutes after they had completed the previous task. This was to let them remove the EEG equipment but mainly to reduce priming effects (Neely, 1991). The memory task was included as it shows the participants the stimuli they would later recall, in order to assess if the brief training away from the emotional material in the dot probe tasks influenced the way these mixed valence words were memorised.

In this task, 10 neutral and 10 negative words used in the dot-probe task were selected at random and displayed one word at a time (See Table 2). Participants were instructed to memorise as many words as possible, as it was suggested they may need to know them later. After participant read the instructions and pressed the space bar to begin the task, each word was presented for 10 seconds before automatically displaying the following word. Each word was on a white background and in Ariel font, size 48. There were no breaks in between words being displayed. After every 10 participants, the words were randomised in order to control for any order effects. Once participants finished they were informed not to remember the 20 words any further.

Table 2: Word valence for 10 positive and 10 negative randomly selected words used in the Memory Task.

Negative Words	Valence	Neutral Words	Valence
Paedophile	1.26	Gas	4.06
Die	1.67	Airhead	4.1
Stress	1.79	Intubation	4.1
Unhappy	1.84	Boomer	4.1
Worthless	1.89	Middleweight	4.1
Overworked	1.9	Crusade	4.24
Worry	2.1	Squint	4.4
Failure	2.15	Migration	4.52
Suicidal	2.15	Gunslinger	4.53
Misery	2.2	Configuration	4.58

2.3 Delayed Free Recall Task

The delayed free recall task is a variation of the standard paradigm of free recall (Blaut et al, 2013). Free recall involves participants studying a list of items in an experiment, and would then be asked to recall the items in any order shortly after. The recall period typically lasts a few minutes. Items can be a variety of stimuli, although traditionally words are used. Delayed free recall is different to the standard paradigm of an immediate free recall as it includes a short time period interpolated between the list of stimuli presented and the start of the recall period, to reduce recency and priming effects.

In the delayed free recall task participants were instructed to write down as many of the 20 words as they can remember from the memory task. They were given a sheet of paper with instructions (see Appendix Figure 7) and the following verbal points: there is no time limit so take however long you need until you feel you cannot remember any more words; spelling does not have to be accurate; if you are unsure if a word was there or not, write it down anyway. Participants were left alone to write down as many words as they could remember, and informed the researcher when they had finished.

2.4 256-Channel Dense Array EEG

The EEG equipment was held in a secured laboratory located in the Psychology department at Huddersfield University. The equipment consisted of three 256-channel HydroCel Geodesic (equidistant) Sensor Net 130 (HGSN), with sizes small (54-56cm), medium (56-58cm) and large (58-60 cm). Additional items included a

Net Amps 300 amplifier- the first in the United Kingdom to be upgraded to be compatible for the demand of the information being produced by the 256-channel HGSN.

2.4.1 NetStation Software

The software used to analyse the data was the 'NetStation 4.5.1 software package'. This software package was created for the acquisition, review and analysis of raw data. It provided unprecedented speed and performance which enabled the processing of data in a fast and simple practice. It provided efficient data review and analysis and allowed interoperability with other software. Dense array EEG data was viewed using a 2-dimensional voltage plot, to visualize brain activity with the highest spatial precision and resolution (EGI, EGI.com, 2014).

2.5 E-Prime 2.0 Software

The dot-probe tasks were created by the psychological analysis software E-prime 2.0 (Psychology Software Tools, 2014). E-Prime 2.0 is a suite of applications which can be used for computerized experimental design, data collection, and data analysis. E-Prime was chosen as it had the ability to create experimental tasks specific to the researcher's project. This is fulfilled by the merge of several different suites which are specialised in a variety of tasks. For example, E-Studio supplied the basic graphical environment for the creation of experiments, with E-Run providing the environment to test and run the different experiments created, alongside stimuli presentation, synchronisation and collection of results. The software provided millisecond precision and could combine and manage large groups of data.

2.6 Role of the Chief Technician

The dot-probe tasks were created in-house by the chief technician at Huddersfield University.
The chief technician was included in this study to help the researcher create the mentioned computerised experiment and was responsible for the equipment used. The chief technician was also able to make the tasks in E-Prime 2.0 compatible with NetStation 4.5.1. In addition, as this project had a limited timeframe the chief technician did not train the researcher in using the EEG equipment and was in charge of fitting during each experiment (although the researcher prepared and helped in fitting the EEG, and ran the experiment itself). Lastly, the chief technician was in charge of giving participants credits through SONA (*see*2.9.1 anonymity and withdrawal of data).

2.7 Design

The research used an independent groups design. The three independent variables were the SE group (high or low) and the attentional manipulation condition (standard or ABM) and the selected time windows of response (200-280,320-400, and 600-900ms).
The categorical factor of self-esteem was a between-subjects variable as it was an independent variable in which different groups of participants were used for each level of the variable, being high or low SE. The categorical factor of dot-probe condition was also a between-subject variable as it was an independent variable in which different groups of participants were used for each level of the variable, being in either a

standard or ABM dot-probe task. However, the IV of time window had three levels which each participant was measured for, therefore was a within-subjects variable.
Word valence was not a within-subjects independent variable as it was not was manipulated by testing each participant for each of its level (i.e. negative or neutral valence), as a typical within-subjects independent variable should. Both negative and neutral words were simultaneously presented at the same time to participants (in the dot-probe task), and they recalled as many words as possible of both word valence in one session (in the delayed free recall task).

From the delayed free word recall task, two dependent variables were measured, being discrete ratio data. They were the negative word recall frequency, and the neutral word recall frequency. A third dependent variable was a continuous ratio variable of attentional bias scores (ms) produced by each participant from the dot-probe task. In addition there was a dependent variable of participants' EEG responses at three selected regions of interest, measured in microvolts (µV). A 2 (self-esteem level: high/low) X 2 (Attentional manipulation: standard/ABM) X 3 (time window: 200-280, 320-400, 600-900) mixed factor design was used on the data, with time window being a repeated measure. All statistical analyses were computed using IBM SPSS Statistical Software version 22.0 (IBM SPSS, 2014).

2.8 Procedure

On arrival of appointed time, participants were informed of the study, their role, and usage of their data/information prior to the start of the experiment. Once any questions were answered, participants then filled in their consent forms alongside the questionnaires used in this study. Their head circumference was measured to determine the appropriate net size to be worn. This was measured by starting at the Glabella and measuring around the head -making sure the tape measure is 1 inch above the Inion when measuring the back of the head. The vertex (or C*z* on the international standard 10-20 system) was found by measuring and marking the midpoint of the nasion and the inion, and measuring and marking the intersection point with the midpoint of the preauricular point of each ear. A soft red pencil was used and participants were informed a small cross would be drawn. A towel was wrapped around participants shoulders to catch any saline solution which may come from the EEG net. The net was prepared and applied as instructed by Electrical Geodesic Inc (EGI; GSN Technical Manual, 2007) by the chief technician, trained by EGI.

Participants were then seated in front of the monitor where the tasks would be carried out, and the Hypertronics connector was attached to the 256-channel Net amps 300 amplifier multi-contact Hypertronics receptacle. The monitor was a 22" LCD display and was fixed to the desk. To improve ergonomics for participants, they were seated 60cm away from the screen with a screen tilt of 10 degrees, as permitted by dim lighting. Instructions were displayed on screen as the researcher also talked through each step presented, answering any questions given. Once the instructions were clear and participants were comfortable, the participants were left to start the dot-probe task. After they had finished, the Hypertronics receptacle was detached and participants were informed the Sensor Net was then going to be removed. Once removed, the Sensor Net was then disinfected and dried and participants had the opportunity to correct their appearance.

After a five minute waiting period between tasks participants then performed the memory task on the same screen. They were presented with instructions and were left alone to complete the task when they were ready. When the task finished, the screen went blank and participants sat back in the waiting area with instructions not to try memorising the words in any way. There was a 5 minute interval before the start of the delayed free recall task, to avoid the effects of priming. Participants were then given instructions regarding the delayed free recall task and were left alone until they communicated that they were finished. Upon completion of the experiment, participants were given a debrief form and were given the opportunity to ask any questions about the research and their participation before leaving.

2.9 Ethical considerations

2.9.1 Anonymity and Withdrawal of Data

The students' university reference numbers (i.e. 103874) were collected. Reference numbers were collected to firstly assign participant numbers for the study (i.e.103874 = participant number 3). Secondly, the reference numbers collected were given to the chief technician of the SONA system to provide participants their credits. The researcher did not process or link the reference numbers with any other participant information, such as their name. The analysis also merged participants' data into 2 groups therefore no single participant's data could be extracted from the analysis. If a participant was to withdraw their data they would have had to contact the chief technician and asked that their data relating to their university reference number be removed. The researcher would then be informed by the chief technician that the relevant participant (i.e. participant 3) has withdrawn. All data would have been removed and analysis would have been recalculated as appropriate. Participants were made aware before, during, and after their participation that they could withdraw their data at any time, in addition they acknowledged this option in their consent form. No participant withdrew from the study.

To ensure there were no other pieces of information which could risk the anonymity of participants (such as writing their name on a sheet), the researcher performed a manual check of all final data to ensure there were no identifying (names, places) or signifying (history, reference numbers) data in the final data set. The final project has complete anonymity for all participants. Therefore, published and/or unpublished work will keep participants anonymous.

2.9.2 Confidentiality

Participants' information was also confidential. This provided additional security as although the previously mentioned procedures prevented identification of participants, participant data would be stored safely and used accordingly. A limited number of individuals were able to access data if desired (Internal and external examiners). The raw data (questionnaire scores, EEG data, and test results) were converted to a digital format, encrypted, and kept on a password protected computer, with the codes/passwords kept on another password secure computer away from the raw data. The data is to be destroyed 5 years after the completion of the researcher's course at Huddersfield University, in accordance with the University's regulations. Data will be destroyed by shredding of all physical material, and permanent deletion of all saved electronic data.

2.9.3 Consent and Dissemination of Results

The aims, methods and measures of the study were given to the participants, and any questions were addressed. Participants were given information about the study and were asked to complete a consent form (See Appendix Figure 6). This was to indicate that they provided permission for their data collected to be used for this study. If a participant required a change to the project, every effort would have been implemented to fulfil their requirements. If it was not possible to make the changes, then a restructure/change in the relevant part of the project would be considered in order to fulfil the participants' request. Advice from the project supervisor would have been sought if new ethical implications were created from the request. Results of the study would be available to all participants. Participants were asked if they would like a copy of the final results, none did. The results may be available at Huddersfield Library for others to view.

2.9.4 Duty of Care

No participant asked what their SE score signified in terms of their current state of mental health. However, a duty of care protocol was formed in case this event occurred. If a participant inquired into the implications of their scores, for example a low SE score, the researcher would state the questionnaires used are not a diagnostic tool for any psychological issues or states, nor are they a substitute for professional clinical help. However, it would be stated that if they felt like they may benefit from professional help, they have the option to do this regardless of the scores from this study.

3 EEG Analyses

3.1 Visual Review

A whole visual review took place by reviewing each participant's data; any bad channels (defined as bad due to a bad connection for more than 30% of the file) were identified and marked bad for the entire recording. After, a bad channel replacement algorithm was run on all data to interpolate the bad channels by using spherical-spline interpolation. NetStation 5 is a sophisticated data analysis program, however it is not able to differentiate the artifacts within a bad eye channel. For example, an eye channel may be bad due to eye blinks, eye movements, or other artifacts. Therefore, eye blinks and movement artifacts were firstly identified automatically using an Ocular Artifact Removal (OAR; Gratton, Coles, & Donchin, 1983) algorithm. This algorithm is able to differentiate between eye blinks and eye movement, which enables the correct calculations and application of different correction factors. The data was then manually verified to further ensure correct removal. Eye blinks were detected with the criteria of being above 140 Microvolts (uV) over a 640ms window, and with no moving average. Eye movements were detected with the criteria of being over 100uV in a 640ms window, with no moving average.

3.1.1 Segmentation

Segmentation involves the process of breaking up the continuous EEG signals into event-related epochs ready to be analysed. The typical epochs are 100ms before and 900ms after stimulus-onset. However as previously mentioned, the Dual Processing Theory (Carver, Johnson, & Joorman, 2008) stated that depression can be hypothesised as comprising of a flexible, strategic and slower processing stream than other clinical disorders. Indeed, a 1000ms stimulus presentation time was used to provides the opportunity for expansion of attentional biases in individuals with the low SE and depressive symptoms.

To ensure the capture of not only the full effect but also the full range of ABM, this study response-locked ERP's therefore the continuous EEG signals were windowed with baseline of 100ms before response-onset, and a 1000ms post-response epoch. The names of predefined ERP's of interest were marked up and matched to the stimuli within each segment at the same point.

3.1.2 Sampling Rate

When gathering EEG data, the relationship between the discretization rate (i.e. digital sampling), and the accurate description of a continuous, analogue, time-series signal in regards it's the highest frequencies, has been known as the Nyquist theorem (Luck, 2014). This theorem suggested that signal frequencies equal to or more than half of the sampling frequency are not represented correctly, therefore a substantial frequency is required to sample high-spatial-frequency features. The discretization rate to provide a digital sample in this study was 240 Hertz. This is known as the sampling rate. The sampling rate is the recording frequency of EEG waveform data, and is recorded in order to convert into a numerical format for analysis. In most digital EEG systems 240 Hz is the commonly used frequency to produce discrete signals.

3.1.3 Impedance

Impedance has been defined as the effective resistance of an electric circuit, opposing alternating currents and is due to ohmic resistance and reactance (*see* Kappenman & Luck, 2010).Minimising impedance was important as it helped to limit the noise in the data caused by a bad connection between the electrode and skin. An amplifier's impedance value was important for analysis in this study as individual amplifier stages were cascaded together one after another in order to minimise distortion of signal. Therefore, impedance was obtained from each electrode, below a cut-off point of 50 Kilo-Ohms (kΩ), by using moderate pressure to 'scrub' each electrode to establish contact with the Stratum Corneum, in order to gain a threshold below the 50 kΩ cut off point. Amplifier systems can differ in input impedance, which means they can vary in their sensitivity to variations of impedance in electrode (Ferree, Luu, Russell, & Tucker, 2001; Kappenman & Luck, 2010). The Net Amps 300 amplifier has an input impedance of 200 mΩ which is sufficient to verify the connection between the scalp and the electrodes is negligible.

3.1.4 Filtering

A first order high-pass filter set at 0.1 Hz was applied to the data to attenuate high frequencies, followed by a low-pass filter at 30 Hz to attenuate low frequency. The vertical electrode was used as a reference. This is used for historical reasons, and enables the comparison of data collected in the past, alongside current data which have also used the same filter settings (Luck, 2014). A notch filter was used with one participant to remove the 50Hz frequency affecting the data.

3.1.5 Clock Synchronisation

Within all EEG experiments it is necessary to verify that the precise timing of all data points. In this study the EEG analysis on one system was triggered by key points in time, being a key press on a keyboard set up on another system. Since two systems with two independent clocks may not have been fully synchronous with one another, known as a temporal drift (Hairston, 2012), the timing and interaction delays needed to be accurately measured. If they were not measured then a potential of loss, reduction, or blurring of any quantities triggered by the events may occur. To correct for temporal drift, a delay response box was used and recorded a time delay of 17ms, (0.017 seconds). This was incorporated into the EEG analysis to reduce drift and prevent asynchrony.

3.2 EEG Analysis

The naming convention on the HydroCel Sensor Net identified the midline locations as 'Z'. The superscripts for each site are typically F (frontal), P (parietal), T (temporal), C (centro), and O (occipital), with variations such as the Fp (prefrontal), CP (centroparietal), and PO (parietal-occipital). Therefore combined references such as the CPz (centroparietal midline) can be formed. Electrodes were references to Cz. The regions of interest (ROI) in this study were the prefrontal line, frontocentralregion, and the centroparietal z line, on the HydroCel Geodesic Sensor Net 130 layout. The prefrontal line consisted of the electrodes 10,11,18,19,25,26,32,33,37,38, and 46. The frontocentral region consisted of the electrodes 13, 14, 15, 20, 21, 22, 26, 27, and 28. The centroparietal z line consisted of the electrodes 101,110,118,119,125,126,127,137, and 138 (See *Figure 3)*. In regards to the ERP's, the neural the activity between the time ranges (epochs) of 200-280ms, 320-400ms, and 600-900ms were of interest in this study.

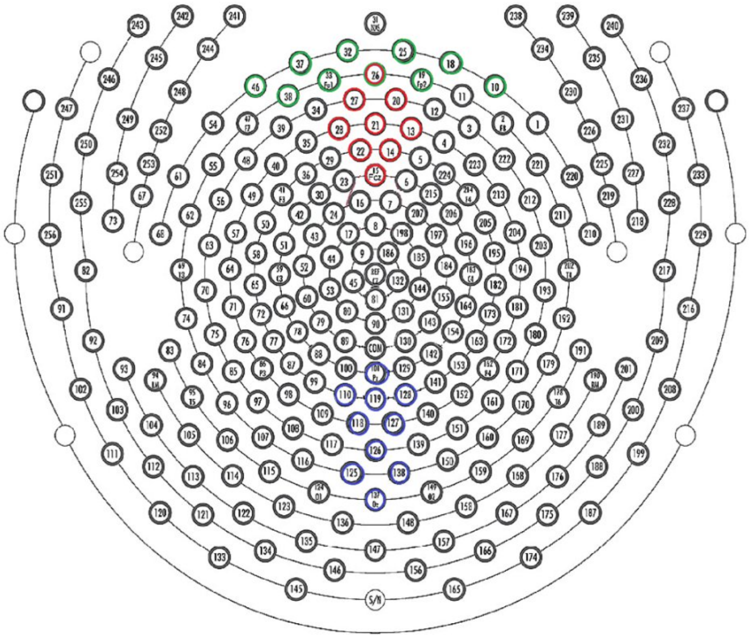


Figure 3: The selected electrodes for the prefrontal line (green), frontocentral region (red), and centroparietal z line (blue), on the HydroCel Geodesic Sensor Net 130 layout.

4 Results

4.1 Behavioural Analysis

4.1.1 Delayed Free Word Recall Task

Warriner et al (2013) stated it could be expected that emotional values to words can be generalised to inflected forms. An example of this is the word *sing* – being the base form (Lemma) of the words *sings, sang, sung,* and *singing.* Therefore any words that participants have written which were inflected forms of the words in this study were accepted as a correctly recalled word.

For the differences in dot-probe condition, in the standard condition for high SE participants there was a total frequency of 50 negative words (mean= 5.18, SD = 1.72). In the ABM condition, there were similarly 54 negative words (mean = 5.40, SD = 1.96). In the standard condition, high SE participants also recalled 38 neutral words (mean= 3.82, SD = 1.72) and 46 neutral words recalled in the ABM condition (mean = 4.6, SD = 2.55) (see Table 3). For low SE participants in the standard dot-probe condition there were 54 negative words (mean = 4.88, SD = 1.73). In the ABM condition there were similarly 53 negative words recalled (mean = 4.82, SD = 2.09). In the standard dot-probe task, low SE participants recalled 41 neutral words (mean = 4.63, SD = 1.59) and 43 neutral words recalled in the ABM condition (mean = 3.91, SD = 1.64).

Table 3: Total frequency and mean amounts of negative and neutral words recalled for both self-esteem groups, in both dot-probe conditions.

Self - Esteem Level	**Dot-probe condition**							
	Standard				ABM			
	Negative Valence		Neutral Valence		Negative Valence		Neutral Valence	
	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)
High	**50**	**5.18 (1.72)**	38	3.82 (1.72)	**54**	**5.4 (1.96)**	46	4.6 (2.55)
Low	**54**	**5.88 (1.73)**	41	4.63 (1.59)	**53**	**4.82 (2.09)**	43	3.91 (1.64)

4.1.2 Sample Characteristics

Lack of skewness (known as symmetry), and kurtosis (known as pointiness or peakedness) have been the main ways in which distribution of collected data deviates from normality. Ideally, any data parameter values would be shown to be zero in a normal distribution however data may be skewed or kurtotic. To assess skewness and kurtosis, z-values were calculated by dividing skewness and kurtosis measures by their respective standard errors. Descriptive exploration was applied to the dependent variables of the frequency of negative word valence recalled, and the frequency of neutral word valence recalled. The independent variable of SE (high/low) was included as the factor.

A Shapiro-Wilk's test ($p>0.05$) (Shapiro & Wilk, 1965; Razali & Wah, 2011) and a visual inspection of the corresponding normality Q-Q plots and histograms showed that the frequency of word recalled were approximately distributed for both frequencies of negative and neutral words recalled.
For the frequency of negative words recalled, a skewness in high SE participants of .21 (SE = 0.51) and a kurtosis of .1 (SE = 0.99) was found. A skewness in low SE participants of -.65 (SE = 0.51) and a kurtosis of

1.66 (SE = 0.99). For the frequency of neutral words recalled, a skewness in high SE participants of .42 (SE = 0.51) and a kurtosis of .44 (SE = 0.35) was found. A skewness in low SE participants of -.44 (SE = 0.51) and a kurtosis of -1 (SE = 0.99). For skewness z scores, if SE= Standard Error then: $Z_{skewness}$ = Skewness -0 / $SE_{skewness}$. For kurtosis z scores, if SE = Standard Error then: $Z_{Kurtosis}$ = Kurtosis -0 / $SE_{Kurtosis}$

Therefore for the frequency of negative word recall, high SE participants' skewness z-value was 0.42, and the kurtosis z-value was 0.01. For low SE participants the skewness z-value was -1.26, the kurtosis z-value was -1.68.For the frequency of neutral word recall, high SE participants' skewness z-value was 0.82, the kurtosis z-value was 0.45. For low SE participants the skewness z-value was 0.86, the kurtosis z-value was -1.01 (see Appendix Figure 12). This suggested that the frequencies of both negative and neutral words recalled by participants were slightly skewed and kurtotic. However they did not differ significantly in terms of normality as all four skewness and kurtosis z-values are within the range of ± 1.96. The number 1.96 was important as it corresponded with the alpha level of 0.05 used in this study. It was used as the sample size was less than 50 (Hae-Young Kim, 2013) as opposed to a range of ± 3.29 used for 50 >300 sample sizes.

4.1.3 Normal distribution

The null hypothesis for the dependent variables was that the data were normally distributed. The null hypothesis would therefore have been rejected if the p-value was below 0.05. A Shapiro-Wilk test of normality was used as Rozali and Wah (2011) stated the Shapiro-Wilk test was designed for less than 50 participants. The Shapiro-Wilk test showed p= 0.119 for the frequency of negative words recalled, and showed p= 0.101 for the frequency of neutral words recalled (see Appendix Figure 13). Therefore the null hypothesis was kept as the Shapiro-Wilk test indicated data were normally distributed.

On visual inspection of graphical figures, the histograms showed an approximate shape of a normal curve (see Appendix Figures 13 & 14), and the dots within the Q-Q plots fell within the line, which indicated the data were approximately distributed (see Appendix Figures 15 & 16). From the previous tests the dependant variables have shown approximate normality distribution for each category of the Independent variable of SE. These results suggested a parametric statistical method was able to be used to further explore and investigate the data.

4.1.4 Accounting for Primary and Recency Effects

Although normally distributed and not significantly skewed or kurtotic, the words recalled in the delayed free recall task may have been affected by primary and recency effects. In the memory task, a list of 20 words was shown to participants - participants may have recalled the first and last words more than the other words presented if primary and/or recency effects were present. If no effects were present then an equal probability of word recall would have been shown for the first 3 (primary) and last 3 (recency) words, in comparison to the rest of the words. If any effects were present then there would be a significant increase in the frequency of the first and last words recalled.

To assess primary and recency effects, an equation was created which calculated the probability of all words recalled by participants, out of the 20 word presented to each participant. Where N= number of participants, R= first 3 words presented to the participant, p= last 3 words presented to the participant, X= total amount of primary words recalled by participants, Z= total amount of recency words recalled by participants, T= highest amount of words able to be recalled, A = actual amount of words recalled, and E= the percentage of those words recalled, then T= N*(P+R), A = X + Z, and E= A/T.
The equation E = (X + Z) / (N* (P+R)) was then formed.

For all participants the probability of recalling one of the first 3 or one of the last 3 words was 9.17% (55/6), as the equation read (73 + 58) / (40* (3+3)) = E, therefore 131/240 = 0.55. When compared to the rest of the words presented to each participant, each word had a 3.21% (45/14) chance of being recalled by each participant, as E= (252 / (40* (7+7)), therefore 252/560 = 0.45. This suggests that there was more than double the chance that a word from the first 3 or last 3 words presented was be recalled when compared to the rest of the words. Overall these findings suggested both primary and recency effects on participants' word recollection in the memory task. However, as word order was randomised after every ten participants, combinations of negative and neutral words were in the first 3 and last 3 words presented to participants. Therefore any order effects were importantly not of any effect in relation to the valence of words recalled.

4.1.5 Word Recall Analysis

For the inferential analysis, although several independent t-test could be used to compare the words recalled in the delayed free word recall task, for both SE and dot-probe conditions, this would lead to 8 separate t-tests. This would increase the risk of the occurrence of a type 1 error whereby a significant difference could be found by chance (Coolican, 2014). Therefore, as an Analysis of Variance (ANOVA) was able to compare many groups at once without inflating the chance of type 1 errors, it held stronger statistical advantage than several t-tests and would be ideally suited to analyse the delayed free word recall task data. A 2-way ANOVA additionally had the ability to find the interaction effects of two or more independent variables which was necessary as the 2 independent measures for this analysis were: SE group (high or low), dot-probe condition (standard or ABM). The relationship between the 2 dependent variables (frequency of negative words recalled and frequency of positive words recalled) was also sought, which a 2-way MANOVA was able to find therefore a 2-way multivariate general linear model (MANOVA) was used on the data.

The assumptions of the data were met for use of a 2-way MANOVA as: the dependent variables were measured at a continuous ratio level, the 2 independent variables each consist of two categorical and independent groups, and the design had independence of observations (different participants in each group). Furthermore, homogeneity of variance assumption was not violated as a Levene's test of homogeneity run on the data between the variables showed no significant results for error variances for negative words (F (3, 36)= 0.15, p=.929), and neutral words (F (3, 36)= 1.21, p=.319) for all participants.

The 2-way MANOVA results showed that there was no significant difference between the high SE (M=5, SD=1.7) and low SE (M=5.88, SD= 5.73) groups in relation to the frequency of negative words recalled (F (1, 39) = 0.124, p= .73, partial eta squared (ηp2) = .003, r = .02) or neutral words recalled (F (1, 39) = 0.003, p=

.96, ηp2 = <.001, r = .01). Therefore SE did not have an effect on word valence recall frequency. Additionally the dot-probe condition did not have a significant effect on the frequency of negative words recalled (F (1, 39) = 0.43, p= .514, ηp2 = .012, r = .09) or neutral words recalled (F (1, 39) = 0.016, p= .9, ηp2 = <.001, r = .07). Specifically relating to low SE participants, dot-probe condition did not significantly reduce negative words recalled (F (1, 21) = 1.8, p= .19, ηp2= .09, r = .25). The interaction effect between SE group and dot-probe condition also did not significantly decrease the frequency of negative words recalled (F (1, 39) = 1.78, p= .19, ηp2= .047) or significantly increase the frequency of neutral words recalled (F (1, 39) = 1.41, p= .243, ηp2= .038).

4.2 Attentional Bias Scores

Attentional bias scores (ms) were calculated for each individual by subtracting the mean neutral word response time with the mean negative word response time. For example, if on average an individual took 600ms to respond to the dot-probe in the incongruent (neutral) position, but only 200ms for the congruent position, then an average attentional bias of 400ms towards the negative word exists for the individual as they take less time to respond therefore attention in the spatial location of the negative stimuli is inferred.

4.2.1 Sample Characteristics

To assess skewness and kurtosis of this dependent measure a Shapiro-Wilk's test (p>.05) (Shapiro & Wilk, 1965; Razali & Wah, 2011) and a visual inspection of the corresponding normality Q-Q plots and histograms was applied on the data. On visual inspection of graphical figures, the histograms did not show an approximate shape of a normal curve, and the dots within the Q-Q plots did not fall within the line, which indicated the data were not approximately distributed. Additionally, the Shapiro-Wilk's test showed the P-values for attentional bias scores for high and low SE groups were <0.05

To prevent skewing of data towards one direction, outliers were identified. The outliers were calculated with the outlier labelling rule (Dovoedo & Chakraborti, 2015). This utilised the 1st and 3rd quartile raw scores along with a multiplier of 2.2 in order to determine the upper and lower boundaries for potential outliers. The outlier results showed that for attentional bias scores the outliers were scores above 90.48ms, or below -89.32ms. Attentional bias scores for participants numbers 2, 5, 6, and 11 were removed before analysis as their mean scores were 292.64, -131.75, 207.74, and 177.89ms respectively (See Appendix Figure 17).

A rerun of the previous test suggested the data was normally distributed as the histograms showed an approximate shape of a normal curve, and the dots within the Q-Q plots fell within the line, which indicated the data were approximately distributed. In addition, the Shapiro-Wilk's test showed the P-values for attentional bias scores of high SE (p= .75) and low SE (p= .5) groups within the criteria of the null hypothesis of normal distribution. Leven's test of equality of error variances was also applied on the data, with the null hypothesis being that the data has equal homogeneity of variance, it showed F (3, 32) = 0.375, p= .772, therefore the null hypothesis was kept as the P-value was higher than the alpha level of 0.05.

4.2.2 Descriptive and Inferential Statistics

For high SE individuals, the average attentional bias score was -15.34ms (SD=20.25) in the standard dot-probe group and 11.16ms (SD= 12.89) in the ABM dot-probe task. For low SE individuals, the average attentional bias score was -5.55ms (SD=15) in the standard dot-probe group and -3.94ms (SD= 20.84) in the ABM dot-probe task. This meant that since the attentional bias scores for high SE participants changes from a negative number in the standard condition (-15.34) to a positive number in the ABM condition (11.16), they directed more attention to negative words in the ABM task when compared to the standard dot-probe task by 26.5ms.

SE level (high or low) and dot-probe condition (standard or ABM) were the two independent variables, and the dependent measure was participants' attentional bias score. Therefore a 2 X 2 ANOVA was applied on the data as this enabled the investigation of any interaction between the two independent variables on the dependent variable. The assumptions of the data were met for use of a 2 X 2ANOVA as: the dependent variable was measured at a continuous ratio level and the 2 IV's each consist of two categorical groups. Furthermore, homogeneity of variance assumption was not violated as a Levene's test of homogeneity run on the data between the independent and dependant variables showed no significant results for error variances for attentional bias scores (F (3, 32)= 0.38, p=.772).

The results of the 2 X 2 ANOVA (see Appendix Figure 18) showed that the dot-probe condition did have a significant main effect on attentional bias scores (F (1, 35) = 5.6, p= .024, ηp2 = .15, r = .63). However SE did not have a significant main effect on attentional bias scores (F (1, 35) = 0.2, p= .658, ηp2 = .006, r = .072. The interaction effect between SE and dot-probe condition showed they had a significant effect on attentional bias scores (F (1, 35) = 4.38, p= .044, ηp2 = .12, r = .528).
The ANOVA showed a main effect of dot-probe condition, and an interaction effect of SE and dot-probe condition. With reference to the descriptive statistics, it was found the inferential results suggested that the ABM dot-probe condition significantly altered the attentional bias scores of high SE participants (-15.34 to 11.16ms) for the 200 word pairs presented in the experiment. This inferred that attention was directed away from neutral words and to the negative words presented. Additionally, there was an interaction effect between SE and dot-probe condition which suggested that the ABM condition had a significantly greater effect on high SE participants than low SE participants (see Figure 4).

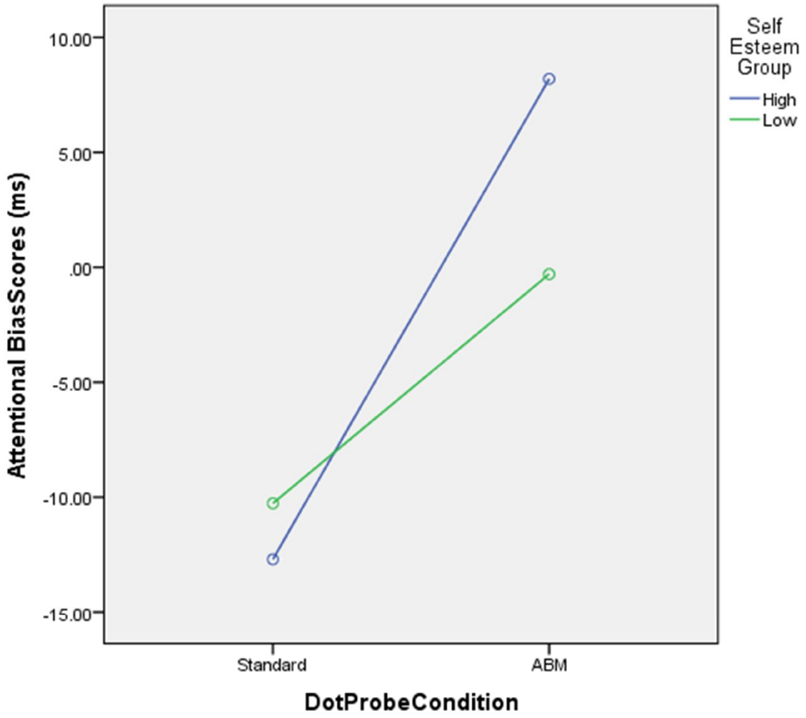


Figure 4: Graph showing the interaction effect of dot-probe condition and SE group on attentional bias scores.

4.3 Self-Esteem and Depression Scores

There was a significant difference between SE levels in this study as the high SE group (M=24.65, SD=2.5) had significantly higher SE than the low SE group (M=18.4, SD=3), t (38) = 7.16, p<.001. A bivariate Pearson's correlation test performed on SE levels and BDI-II scores for all participants showed a strong positive correlation (C (40) = -0.662, p<.001) between SE (M=21.52, SD=4.18) (see Appendix Figure 19), and depression scores (M=7.43, SD= 6.77). This result supported findings by Sowislo and Orth (2012) that SE and depression have a strong positive association. However as opposed to Sowislo and Orth (2012) who suggested SE predicted depressive symptoms, a unidirectional prediction could not have been established in the current study instead only associative strength could be found.

4.4 Neurological Analysis

4.4.1 Sample Characteristics

On exploring the raw EEG recordings for participants, there were possible extreme values when manually viewing the data in SPSS, therefore outliers were calculated with the outlier labelling rule (Dovoedo & Chakraborti, 2015) as previously used. The outlier results showed that for the three regions of interest across the three epochs that participants numbered 7, 16, 22, and 31 were outliers in the data. Additionally the descriptive outcome in SPSS highlighted these participants on a box plot (see Appendix Figure 20). EEG recordings for participants numbered 7, 16, 22, and 31 were removed before analysis.

To assess skewness and kurtosis of the EEG recordings, a Shapiro-Wilk's test (Shapiro & Wilk, 1965; Razali & Wah, 2011) and a visual inspection of the corresponding normality Q-Q plots and histograms was applied on the data. The dependent variable was the EEG amplitudes for the three regions of interest, and three independent variables were the dot-probe condition (standard or ABM), SE group (high or low), and epochs measures for each participant (200-280, 320-400, or 600-900ms).

On visual assessment of normality box plots and histograms, the histogram for the ABM dot-probe condition showed an approximate shape of a normal curve (see Appendix Figure 21), and the dots within the Q-Q plots fell within the line (see Appendix Figure 22), which indicated the data were approximately distributed. However, for the histogram showing distribution for participants in the standard dot-probe condition, the data may have been kurtotic, specifically platykurtic (see Appendix Figure 23).

Therefore in combination with the visual inspection of the graphs, a Shapiro-Wilk's test (p>0.05) (Shapiro & Wilk, 1965; Razali & Wah, 2011) was also performed on the data with the null hypothesis that there would have been no statistically significant difference between the data which was examined and a normal frequency distribution. The results of the Shapiro-Wilk test suggested that this hypothesis could be accepted as the P values for the 3 regions of interest in both standard and ABM dot-probe conditions were above 0.05 (Standard: Prefrontal, p= .22; Frontocentral, p=.32 , Centroparietal, p= .084. ABM: Prefrontal, p= .68; Frontocentral, p=0.67, Centroparietal, p= .86) (see Appendix Figure 24).

4.4.2 Descriptive Statistics for the Regions of Interest

The descriptive statistics for the prefrontal line indicates that for the epoch of 200 - 280ms participants in the standard dot-probe task had a mean amplitude of 17.7 (SD= 7.25), for the epoch of 320 - 400ms participants had a mean of 10.44 (SD= 7.95), and for the epoch of 600 - 900ms participants had a mean of 12.34 (SD= 10.84). In comparison, participants in the ABM dot-probe task displayed a mean of -3.54 (SD= 17.3) at 200 - 280ms, a mean of -16.1 (SD= 17.56) at 320 - 400ms, and a mean of -10.05 (SD=20.81) at the 600 - 900ms range. Therefore the differences in µV between both dot-probe conditions for the three time windows were 21.24, 26.54, and 22.39 respectively.

The descriptive statistics for the frontocentral region indicates that for the epoch of 200 - 280ms participants in the standard dot-probe task had a mean amplitude of 13.6 (SD=6.5), for the epoch of 320 - 400ms, participants had a mean of 7.6 (SD=8.39), and for the epoch of 600 - 900ms, participants had a mean of 10.6 (SD= 9.8). In comparison, participants in the ABM dot-probe task displayed a mean of 10.66 (SD= 18.16) at 200 - 280ms, a mean of 2.5 (SD= 21.45) at 320 - 400ms, and a mean of 3.2 (SD=21.24) at the 600 - 900ms range. Therefore the differences in µV between both dot-probe conditions for the three time windows were 2.94, 5.1, and 7.4 respectively (See Table 4).

Lastly, the centroparietal z line descriptive statistics indicate that for the epoch of 200 - 280ms in the standard dot-probe condition, participants displayed a mean amplitude of 4.63 (SD=19.81), for the epoch of 320 - 400ms, participants had a mean of 6.11 (SD=16.45), and for the epoch of 600 - 900ms participants displayed a mean of 5.11 (SD= 16.5). In comparison, participants in the ABM dot-probe task displayed a mean of -14.8 (SD= 26.6) at 200 - 280ms, a mean of -12.4 (SD= 26.3) at 320 - 400ms, and a mean of -13.7

(SD=26.14) at the 600 - 900ms range. Therefore the differences in µV between both dot-probe conditions for the three time windows are 19.43, 18.51, and 18.81 respectively.

Table 4: Means and standard deviations for the regions of interest and 3 temporal windows, for both dot-probe conditions.

Dot-probe condition	**Standard:** Mean (Standard Deviation)			**ABM:** Mean (Standard Deviation)		
ROI	Prefrontal	Frontocentral	Centroparietal	Prefrontal	Frontocentral	Centroparietal
Times (ms):						
200-280	**17.35 (7.21)**	*13.94 (6.52)*	4.63 (19.81)	**-11.02 (32.13)**	*13.4 (35.6)*	-14.8 (26.6)
320-400	**10.44 (7.95)**	*8.31 (8.06)*	6.11 (16.45)	**-24.34 (27.28)**	*3.62 (29.17)*	-12.4 (26.3)
600-900	**12.34 (10.84)**	*11.4 (9.5)*	5.11 (16.5)	**-18.96 (30.56)**	*8.31 (33.85)*	-13.7 (26.14)

4.5 Inferential Analysis - Prefrontal Line

4.5.1 Equality of Variance

To test for sphericity, being the assumption that variance of the differences between the combinations of groups and their levels are equal, a Mauchley's test of sphericity was applied on the data (Mauchley, 1940). The null hypothesis of Mauchley's test of sphericity was that the variances of the data were equal.

The within subjects effects of the time (levels: 200-280, 320-400, 600-900ms) did satisfy the assumptions of Mauchley's test of sphericity (M= 0.94, p=.434) (see Appendix Figure 26). Specifically, the test assumed that the F statistic was not positively biased therefore did not renderer it invalid, with a type 1 error occurrence not probable, therefore not violating sphericity. The null hypothesis of Mauchley's test of sphericity was accepted and the alternative correction factor of the Greenhouse–Geisser value was not used when reporting within-subjects effects. If sphericity was not assumed the Greenhouse–Geisser test could have been used as it would have provided a corrected and more accurate significance value by recalculating it to compensate for the liberality of the significance value produced.

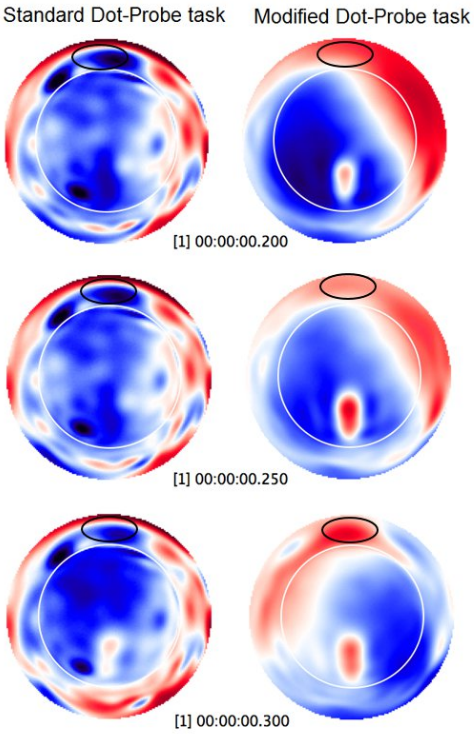
4.5.2 Within-Subjects Effects

With assumed sphericity, the results showed that the within subjects effect of time did have a significant main effect on EEG amplitude for all participants (F (2, 54) =26.5, p<.001, ηp2 = .5, r =1).There was also a significant effect of time and SE on EEG amplitude for all participants (F (2, 54) = 3.9, p=.026, ηp2 = .126, r =.68).There was also a significant effect of time and dot-probe condition (F (2, 54) = 3.61, p=.034, ηp2 = .118, r (r) =0.64). Lastly, there was a significant effect of SE, time, and dot-probe condition (F (2, 54) = 3.2, p=.047, ηp2 = .11, r =.59).

4.5.3 Between-subjects effects

For the between group effects, three Leven's test was applied on the data. The Leven's tests (see Appendix Figure 27) showed that the differences in variances between the three epochs recorded in the prefrontal line were equal between each group (200-280: F (3, 27) =2.3, p= .1, 320-300: F (3, 27) =1.2, p= .33. 600-900: F (3, 27) = 0.85, p= .478). The 3 X 2 X 2 ANOVA showed SE did not have a significant main effect (F (1, 27) = 0.17, p= 0.69, ηp2 < 0.001, r = 0.07). However the main effect of dot-probe condition did show significance (F (1, 27) = 19.6, p= .001, ηp2 = .42, r = .68) (see Figure 6). Together, the interaction effect of SE and dot-probe condition did not have a significant effect on amplitude in the prefrontal line (F (1, 27) = 0.97, p= .33, ηp2 = .35, r = .16).

As time did have a significant main effect on EEG amplitude, a Bonfferoni post hoc test compared the repeated measure variable of time at its three levels (200- 280, 320-400, 600-900ms). It showed a significant difference between epochs 1 and 2, 1 and 3, as well as 2 and 3. This referred to amplitudes in the epoch of 200-280ms after response, having possessed significantly different amplitudes to those in the range of 320-400ms after response (mean difference = 12.33, p<.001). Between the epoch of 200-280ms and 600-900ms there was a significant difference in amplitude (mean difference= 7.34, p< .001). Lastly, between 320-400ms and 600-900ms there was also a significant difference in amplitudes (mean difference= 4.92, 0.034) (see Appendix figure 4).



Blue = positive amplitude. Red= negative amplitude. The prefrontal line has been circled to visually compare the region's amplitude.

Figure 5: Grand average topographic maps for all participants showing the average scalp distribution for the P2 component in the standard dot-probe condition and the N2 component in the ABM dot-probe condition.

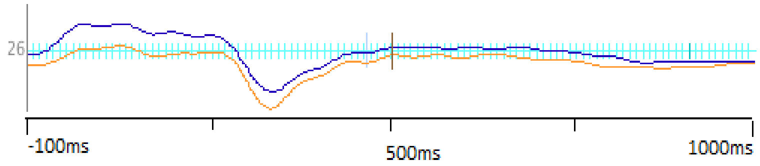


Figure 6: Grand average ERP amplitude for standard dot-probe condition participants at electrode site 26 in the prefrontal line.

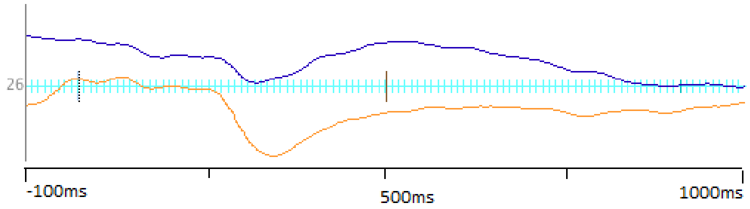


Figure 7: Grand Average ERP for ABM dot-probe condition participants at electrode site 26 in the prefrontal line.

4.6 Inferential Analysis - Frontocentral Region

4.6.1 Equality of Variance

The within subjects effect of the time (levels: 200-280, 320-400, or 600-900ms) did satisfy the assumptions of Mauchley's test of sphericity (M= 0.778, p=.096) (see Appendix Figure 27). The null hypothesis of Mauchley's test of sphericity was accepted and results were reported assuming sphericity.

4.6.2 Within-Subjects Effects

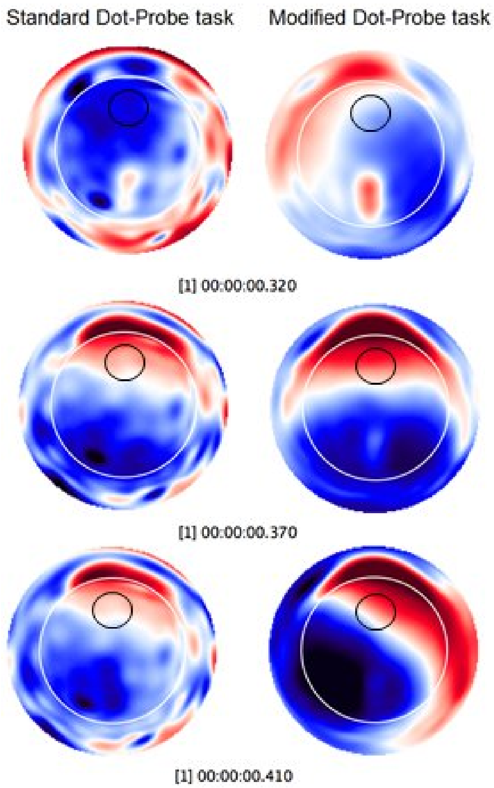
The results showed that the within subjects effects of time did have a significant main effect on EEG amplitude for all participants (F (2, 60) =14.62, p<.001, ηp2 = .33, r = .99). However, there was not a significant effect of time and SE on EEG amplitude (F (2, 60) =0.68, p=.51, ηp2 = .22, r=.16). There was no significant effect of both time and dot-probe condition (F (2, 60) = 1.36, p= .264, ηp2 = .04, r =.28). Lastly, there was not a significant effect of SE, time, and dot-probe condition (F (2, 60) = 0.13, p= .876, ηp2 = .04, r =.07).

4.6.3 Between-Subjects effects

The results of the Levene's tests showed that 2 out of 3 data sets for the time dependent variable were not homogenous (see Appendix figure 29). One assumption of an ANOVA test was that the variance of each cell of the design was not significantly different from the other. However the Levene's test showed this was not the case for the two groups in the frontocentral region. Within the context of all the data in this project, 7 out of 9 data sets did not violate the assumptions of the Levene's test, all data had correct normality assumptions, and an ANOVA had relative robustness under those conditions (Field, 2013). Due to these factors, the violation within these two groups was waivered and variance between groups was not stabilized.

The 3 X 2 X 2 ANOVA showed SE did not have a significant main effect (F (1, 30) = 1.71, p= .2, ηp2 = .05, r = 0.25). The main effect of dot-probe condition also did not show significance (F (1, 30) = 1.1, p= .314, ηp2 = .03, r = .168 (see Figure 9 & Figure 10). Together, the interaction effect of SE and dot-probe condition did not have a significant effect on amplitude in the prefrontal line (F (1, 27) = 0.04, p= .85, ηp2 < .001, r = .05).

As time did have a significant main effect on EEG amplitude, a Bonfferoni post hoc test was performed and showed a significant difference between epochs 1 and 2, and 1 and 3, but not 2 and 3. This referred to amplitudes in the time range of 200-280ms after response, possessing significantly different amplitudes to those in the range of 320-400ms after response (mean difference = -6.97, p<.001). Also between the time range of 200-280ms and 600-900ms there was a significant difference in amplitude (mean difference= 5.11, p= .004) (see Appendix figure 31).



Blue = positive amplitude. Red= negative amplitude. The frontocentral region has been circled to visually compare the region's amplitude. The similar colours when comparing the same time between dot-probe conditions signifies similar amplitudes, therefore no significant differences.

Figure 8: Grand average topographic maps for all participants showing the average scalp distribution for the P3 component in the standard dot-probe condition and similarly the P3 component in the ABM dot-probe condition.

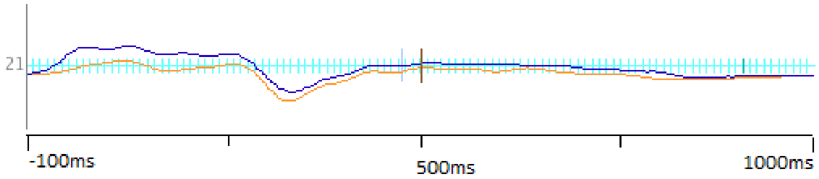


Figure 9: Grand average ERP amplitude for standard dot-probe condition participants at electrode site 21 in the frontocentral region.

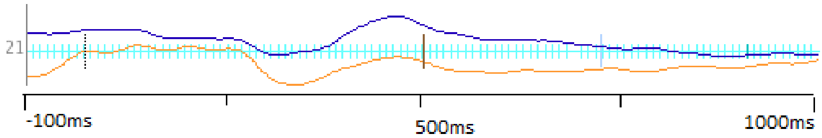


Figure 10: Grand Average ERP for ABM dot-probe condition participants at electrode site 21 in the frontocentral region.

4.7 Inferential Analysis - Centroparietal z line

4.7.1 Equality of variance

The within subjects effects of the time (levels: 200-280, 320-400, or 600-900ms) did satisfy the assumptions of Mauchley's test of sphericity (M= 0.83, p=.77) (see Appendix Figure 28). The null hypothesis of Mauchley's test of sphericity was accepted and results were reported assuming sphericity.

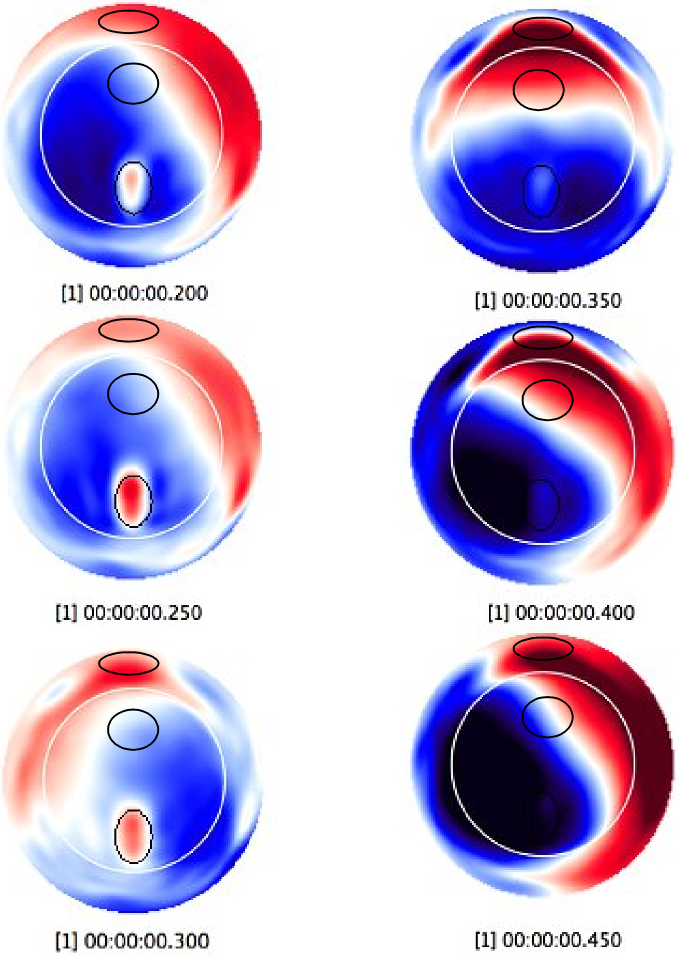
4.7.2 Within-Subjects Effects

The results showed that the within subjects effects of time did have a significant main effect on EEG amplitude for all participants (F (2, 58) =7.09, p=.003, ηp2 = .2, r = .88). There was not a significant effect of time and SE on EEG amplitude (F (2, 58) = 0.23, p=.76, ηp2 = .01, r =0.08). There was no significant effect of both time and dot-probe condition (F (2, 58) = 0.02, p= .96, ηp2< .00, r =.053). Lastly, there was not a significant effect of SE, time, and dot-probe condition (F (2, 58) = 2.57, p= .094, ηp2 = .08, r =.5).

4.7.3 Between-Subjects Effects

For the between group effects, three Leven's test was applied on the data. The Leven's tests also showed that the differences in variances between the three different epochs recorded in the centroparietal line were equal between each group (200-280: F (1, 32) = 0.6, p= .45, 320-300: F (1, 32) = 0.06, p= .81. 600-900: F (1, 32) = 0.19, p= .467) (see Appendix figure 33).The between subjects tests showed SE did not have a significant main effect (F (1, 29) = 3.54, p= .07, ηp2 = .11, r = .44). The main effect of dot-probe condition also did not show significance (F (1, 29) = 2.74, p= .109, ηp2 = .09, r = 0.36 (see Figure 12). Together, the interaction effect of SE and dot-probe condition did not have a significant effect on amplitude in the centroparietal z line (F (1, 29) = 8.67, p= .006, ηp2 = .23, r = .812).

As time did have a significant main effect on EEG amplitude, a Bonfferoni post hoc test was performed and showed a significant difference between epochs 1 and 2. This referred to amplitudes in the epoch of 200-280ms after response holding significantly different amplitudes to those in the epoch of 320-400ms after response (mean difference = -2.22, p<.001) (see Appendix figure 32).



Blue = positive amplitude.
Red = negative amplitude.
This colour contrast has been be illustrated in the prefrontal, frontocentral, and centroparietal Z line regions as circled.

Figure 11: To the left: Topography of amplitudes between 200-280ms for all participants. To the right: significant differences in amplitude at 320-400ms when compared to the topographies on the left.

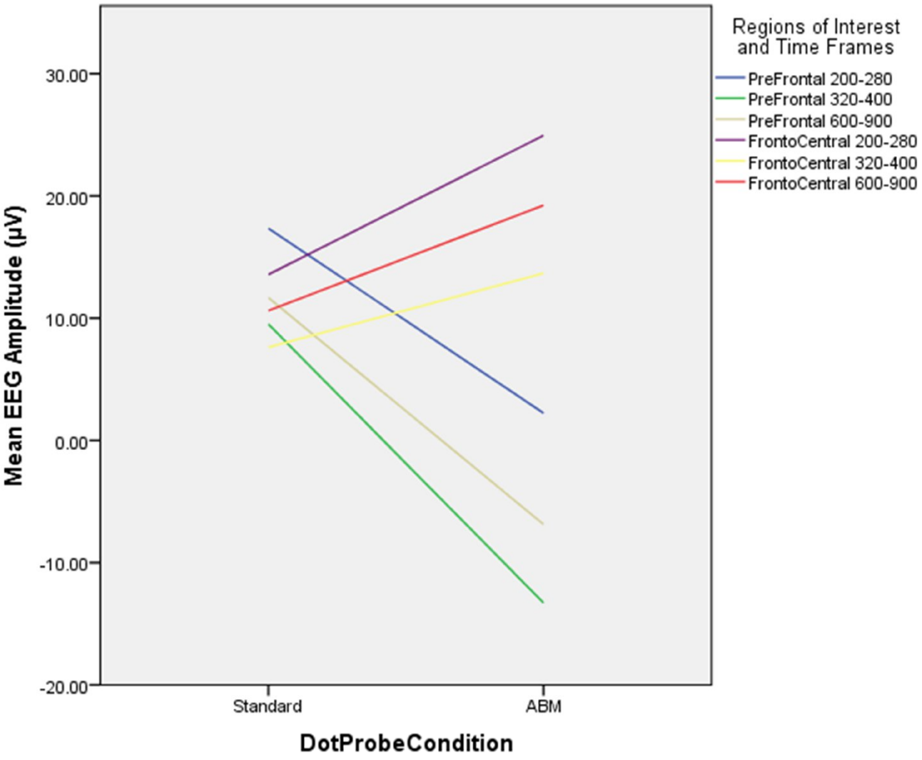


Figure 12: Table showing the significant reduction in the prefrontal line, and the non-significant difference in the frontocentral region between dot-probe groups, at three epochs are presented.

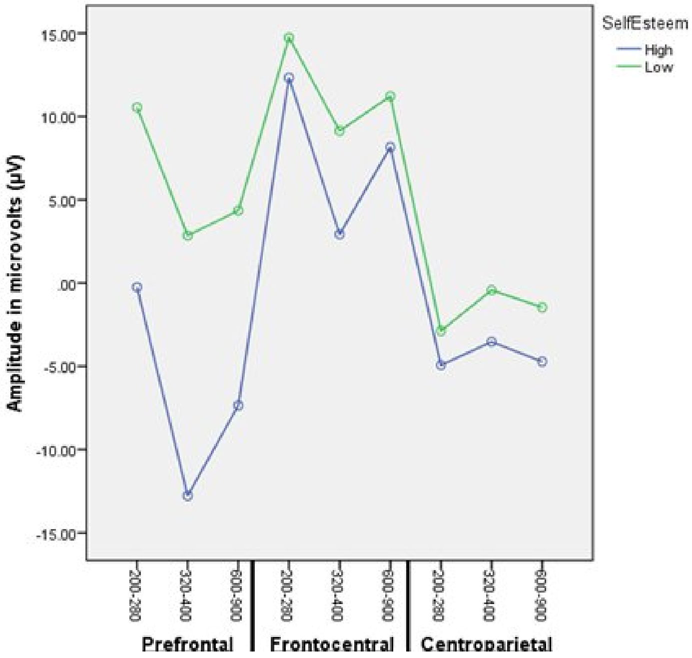


Figure 13: A graph to show the significant difference between SE levels with time being a main factor, in the prefrontal line, with no significances found in the other regions.

5 Discussion

5.1 Behavioural Results

5.1.1 Delayed free word recall task

In regards to the words recalled in the delayed free word recall task, there were no significant differences found within or between any of the variables analysed. It was hypothesised that there would have been a significant reduction in negative words recalled by low SE participants in the ABM dot-probe condition compared to low SE participants in the standard dot-probe condition. However this was not found, as the dot-probe condition did not significantly affect the negative word recall frequency for low, nor high, SE participants. In addition, it was hypothesised that within the ABM dot-probe condition, there would have been a significant decrease in the amount of negative words recalled by low SE participants when compared to high SE participants. However, again this was not reported. Hypotheses 1 and 2 were rejected and their opposing null hypotheses were accepted.

A useful tool to assess the practical significance of this result, the partial eta squared for the variance in negative word recall frequency between SE group and dot-probe task was .047. This effect size has been defined as the ratio of variance accounted for by an effect and that effect again, plus the associated error variance (Field, 2013). In other words, partial eta squared is the proportion of variance in the dependent variable explained by the independent variable. Formulaically, it is defined as $\eta_p^2 = SS_{effect} / (SS_{effect} + SS_{error})$.The ηp2 results for the effects of both SE and dot-probe condition suggested that 4.7% of the variation was due to the effects of the combination of these two IV’s. Additionally 3.8% of variance for neutral word recall frequency was accounted for by the effects of SE group and dot-probe task. This was not sufficient enough to warrant that the two IV’s strongly affected participants’ attention and memory towards neutral, or away from negative valence word presented.

The absence of findings for any main or interaction effects of SE or dot-probe condition on negative or neutral word recall was contradictory to findings by Blaut et al (2013). They found significant effects for recalled words used in their study when analysing BDI scores, word valence, and group, along with their possible interaction. Their methodology was similar to this study as participants completed either a standard or ABM dot-probe task and were presented with words randomly chosen and of opposing valence, with participants then writing down all the words they could in a free recall task. It was found by Blaut et al (2013) that attention was trained away from negative words in individuals with elevated scores of depression. This was evident by the absence of a memory bias for negative adjectives, while participants in the control condition still displayed this memory bias.

A possible explanation for this differences in results may have been due to the stimuli used. The present study did not use adjectives for the memory task. The effect of adjectives on the individual was explained by Blaut et al (2013) as they described that adjectives are more likely to be self-referenced when read. If the stimuli used were negative words but also self-referential, then participants with a higher association of endorsement of negative description towards their self may have increased direction of their attention towards the stimuli. The words used in this study may not have had the strength of effect from adjective usage as they were a mix of verbs (die, squint), adjectives (unhappy, suicidal), and nouns (failure, configuration) which may have meant participants interpreted and engaged with the words in a less self-referential way compared to adjective words.

As posited by the CCBH (Everaert et al., 2014) the behavioural results in this study should have displayed significant differences between dot-probe conditions, as the modalities of attention, interpretation, and memory are theorised to be linked. By not showing a change towards a prescribed contingency, the findings in this study infer there was no interlink between the processes of attention and memory. However, this study theorised that due to the lesser extent of self-relevant interpretation, participants in the current study did not encode the word types sufficiently to facilitate a lasting interaction with the processes in memory. Therefore the ABM technique would have no effect on memory when recalling the words later on. The opposing results to the assumptions of the CCBH may not have been from an absence of interplay between attention and memory, instead from a lack of self-relevant stimulation necessary to activate the malformed cognitions which would automatically deploy both attention and memory mechanisms to the negative stimuli. To explain differently, participants whom encoded adjectives in the study by Blaut et al (2013) at a greater self-referential level than participants in the current study, may have deployed more time and encoding resources to remembering the words shown. Participants in the ABM condition may have been more influenced by the attentional training received as it would have limited the amount of encoding performed on the adjectives viewed, thus creating insufficient encoding time to memorise their contingent relevance to one's self.

The notion that stimuli needed to be used which had sufficient properties to trigger processes of both attention and memory, was concurred by the secondary finding by Blaut et al (2013).They found there was no effect of ABM when nouns were used in the training procedure. Unfortunately, the word recall tasks in both Blaut et al (2013) and the current study were not able to specify the operational mechanisms accountable for the link between attention and memory. However, and beyond the scope of this project, deeper investigation into the type of stimuli used to theoretically facilitate mechanisms of attention and memory are required, i.e. although strong in valence levels, how self-relevant would words or pictures need to be in order to obtain their desired effect.

5.2 Attentional Bias Scores

It was hypothesised there would have been a significant increase in attentional bias scores away from negative stimuli for the ABM condition, compared to the standard dot-probe condition. This meant the ABM condition would have trained participants to reduce their attentional deployment to negative stimuli when presented together with neutral stimuli. However, the opposite effect was created whereby the ABM dot-probe condition significantly increase participants' attention towards negative stimuli. This finding was in contradiction with the underlying assumption of the modified ABM dot-probe task, as scores of attentional bias should have changed in favour of neutral or positive stimuli due to learned redirection. Due to the opposing trend of these attentional bias findings, the hypothesis for this study (hypothesis 3) was rejected and the null hypothesis was accepted.

In further contradiction, there was also an interaction effect of dot-probe condition and SE which showed the effect of the ABM condition was significantly increased when SE was high compared to when SE was low (see figure 4). This meant, it was hypothesised that low SE participants would significantly improve their attentional bias scores due to the beneficial effects of the ABM condition, but instead the high SE participants were negatively affected by the mechanisms of the ABM condition and low SE participants did not benefit as predicted. Hypothesis 4 was therefore rejected and the alternative, or null, hypothesis was accepted.

Figure 14 details an expanded description of figure 4, to illustrate these different effects. The 2 lines comparing SE groups was averaged to form a third, mean line (dashed red) which represented the main effect of dot-probe task on both SE groups. Conversely, whilst not considering the dot-probe condition, another average line (dashed brown) was created by comparing average SE scores in low SE participants, and the average SE scores in high SE participants. The black dashed line indicates the interaction effect of SE and dot-probe condition, as SE significantly influenced the effectiveness of the ABM condition, by increasing high SE participants attention to negative stimuli compared to low SE participants.

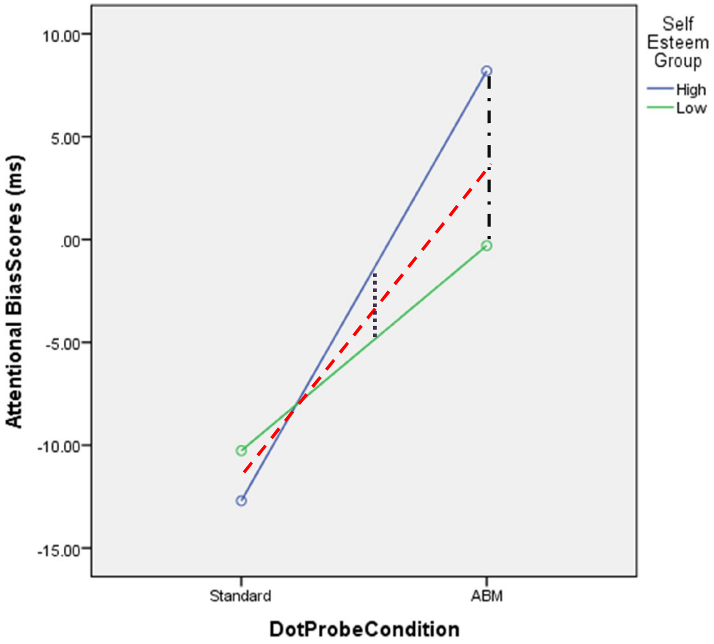


Figure 14: Graph showing the effect of SE and dot-probe condition on attentional bias scores.

One possible explanation for the interaction effect found was that the more high SE participants were trained to attend away from negative stimuli, the more the negative stimuli would violate the positive views they possess about themselves, when processed in relation to individual familiarity. As their attention to negative words was theorised to decrease in the ABM condition, this created a counter effect whereby an increase in inconsistencies between their positive SE esteem cognitions and the negative stimuli presented, was formed. This effect was not demonstrated in low SE participants as they were theorised to have self-referential cognitions which more closely corresponded to the words presented.

However it was important to note that this finding, that the effects of an ABM session can be negatively consequential for the response times of high SE participants, is ostensible. Although significance was found, the time range which had been captured translated to a very small, barely noticeable behavioural response. This meant that although the ABM task was mediated by SE, when applied to real world observation a delay of around 20ms, being 0.02 seconds, may not be a meaningful disparity and may have a limited scope when applied as a behavioural response. An improvement to solve this point would be use stimuli which would have a more distinct effect between high and low SE participants, such as negative and neutral images from the international affective picture system (IAPS; Lang, Bradley, & Cuthbert, 2008). This may facilitate a greater difference of attentional bias scores that may be behaviourally distinguishable, thus essentially lending stronger evidence for the mentioned explanation for the findings in the current project. This does however reinforce the argument to include neurological measures within dot-probe research as observational and behavioural results, such as in this study, may draw limitations in their findings but may be able compliment neurological findings if both methods are applied.

5.3 Neurological Analysis

5.3.1 Between subjects factor of SE

For the 3 regions of interest, SE did not have a significant main effect. This meant that high SE participants did not have significantly different amplitudes compared to low SE participants, when discounting dot-probe condition. Hypothesis 6 stated that within the ABM condition, low SE participants would have had significantly different amplitude in response to negative words, when compared to high SE participants, at all three time windows of interest. This was theorised since the ABM condition may have had different abilities to alter amplitude in each of the two SE groups. This hypothesis was rejected and the null hypothesis was accepted as SE was shown not to be significantly different in either dot-probe conditions.

Rejection of the experimental hypothesis was a surprising result in term of the regions selected to be investigated. A possible explanation for the absence of any significant effect of SE on participant amplitude when viewing the stimuli in this study, may be due to an erroneous choice of location to measure the subsequent processes. However, for the prefrontal and frontocentral areas, the electrodes which define each region were chosen as they lay around the central line of the prefrontal cortex, which included structures relevant to the processing of the self (Denny, Kober, Wager, & Ochsner, 2012). Specifically they lied around the medial prefrontal cortex (mPFC). Northoff et al (2006) displayed that self-judgments were associated with a select group of cortical frontal midline structures which included the medial prefrontal and cingulate cortices, after they meta-analysed 27 *f*MRI studies. Chavez and Heatherton (2015) additionally found that individual differences in SE were underlined by multi-modal frontostriatal connectivity which involved the connections between the mPFC and ventral striatum. Beer, Lombardo, and Bhanji (2010) suggested the ventral anterior cingulate cortex, orbitofrontal cortex, and medial prefrontal cortex have been involved in self-evaluation, being conceptually close to SE (Beck, Steer, Epstein, & Brown, 1990). Additionally, although past research into the concept of the self has highlighted its complexity, self-referential processing systems have recently been revealed and have received a high level of agreement across more than 100 studies (see Denny et al., 2012). They also suggested that activity in the mPFC is consistently associated with self-referential processing, across a variety of paradigms. The mPFC has been suggested to be recruited when processing information during the evaluation of the self, and supports the role of self-representation. Therefore the electrodes chosen to represent the prefrontal and centroparietal regions were capturing responses from a well-known self-processing region.

However, as is has been shown there are many different types of self, it has been shown that a plethora of other regions cognitively process self-relevant information. These structures can have a wide spread of locations in the prefrontal cortex and include the ventral and dorsal medial prefrontal cortices, posterior cingulate cortex, anterior cingulate cortex, as well as the mPFC (Wu et al, 2014). These areas have been associated with judgments relevant to the self in the presence of verbal, facial, emotional, and several other domains, therefore it was possible that the region of the mPFC measured in this study may not have been the most optimal when processing the specific stimuli in this study, in relation to SE. More research into the specific capabilities of each region within the prefrontal cortex may have found a more appropriate target and changed the electrodes to match. Alternatively as the electrodes making up the prefrontal and frontocentral regions in this study capture a small area of the mPFC (see Figure 3), a wider range of electrodes may have been required to cover a larger area of the prefrontal cortex to capture response of these multiple areas.

5.3.2 Between Subjects Factor of Dot-probe Condition

Only found in the prefrontal line, the dot-probe task had a significant main effect on amplitude (see figure 4). The reduction from positive potentials to negative potentials at all three time windows (see figure 12) signified that the ABM dot-probe condition was able to manipulate attentional processing in response to negative stimuli. Previous findings by Jurcak et al (2007) stated amplitudes tend to decrease in response to more negative compared to more positive information. Therefore a possible explanation of ERP changes from P2 to N2 between dot-probe conditions was because less processes of attention were being performed in the ABM condition. The ABM dot-probe task manipulated attention towards neutral stimuli, by showing the probe with a 90% probability of being in the neutral stimuli position. However, when a probe fell in the negative stimuli position, the effect of the negative stimuli on participants increased as there was a higher violation against the trend of attending to the neutral probe 90% of the time.

In opposition to the P2 ERP, the N2 can be stimulus driven, and has been shown to be a strong frontal and central negative deflection (Olvet and Hajcak, 2008), it also has an association with monitoring of stimuli conflict (Donkers & van Boxtel, 2004; Enriquez-Geppert et al, 2010; Larson et al, 2014; Randall & Smith, 2011). These findings concurred with the current study that negative amplitude increased when the negative stimuli caused greater conflict of expectations of where to deploy attention. Hypothesis 5 stated there would have been a significant decrease in low SE participants' amplitude when responding to negative stimuli, for the ABM condition compared to the standard dot-probe condition. This hypothesis was able to be partially accepted under the terms that it only applied to the area of the mPFC selected and not in the other two sites.

Regarding the absence of modification in the centroparietal z line, unlike the prefrontal area, this region has shown less links with self-referential processing and more with perceptual and selective processing. An increased positivity has been implicated in greater intensity of processing negative emotional stimuli (Yang et al., 2012) with the use of words having been shown to enhance the late LPP over parietal regions

(Fischler & Bradley, 2006). One justification in this study for measurement of the centroparietal z line was that over centroparietal sites, Schupp, Junghofer, Weike, and Hamm (2004) found that later selective processing effects were specified by enlarged positive LPP amplitudes when presented with emotional compared to neutral stimuli. This suggested that negative words (which may be self-referenced in the prefrontal region) would activate the centroparietal region with increased activation when stronger negative stimuli were presented.

In relation to the current study, if the ABM condition was able to modulate attention to the negative stimuli then a decrease in positivity in the centroparietal region would be shown and would have represented less attention to the stimuli. Unfortunately, although there was amplitude reduction, this did not significantly occur. Thus, this ERP finding strongly supported the indication that the ABM condition was not able to significantly manipulate attention to counteract the valence of negative words when presented to participants.

Accepting hypothesis 5 for the prefrontal line was taken with caution as high SE participants were included in this main effect found from dot-probe condition. This meant low SE participants were influenced as much as high SE participants in both dot-probe conditions. Deliberation for this outcome needed to be performed in terms of the theoretical and practical consequence of the ABM dot-probe task. It was the specific finding of the low SE group which were of more interest as they were able to provide more applicable prediction on the efficacy of ABM. As the previously mentioned main effects of SE or dot-probe condition incorporated and collapsed the other variables to provide general effects and did not take into consideration the interaction with other IV’s, the findings of the between subjects interaction held more important fundamental results.

5.3.3 Between Subjects Interaction Effect

In the three regions of interest, amplitude was not significantly different between the 2 SE groups, when in different dot-probe conditions. Therefore no interaction effect of SE and dot-probe condition was found. This was dissimilar to the theoretical underpinnings of ABM, as participants who display higher evaluation pertaining to an attention bias associated with negative effects (i.e. low SE) should show a decrease in neurological processes of attention towards the congruent (negative) stimuli. Instead no group showed significant neurological improvement from the ABM condition.

As there have been mixed results of significance for the prefrontal line, the interaction effect between SE and dot-probe condition may have been cancelled out by the non-significance for the main effect of SE when compared to the significance of the dot-probe task. To investigate the strength of the interaction effect, the η_p^2 for SE was .001 and was interpreted to suggest SE caused less that 1% variance, yet the η_p^2 result for the main effect of dot-probe condition was .42. This was interpreted to propose 42% of the variance associated with the dot-probe condition was accounted for by dot-probe task. Together, since there was no significant interaction effect, there was no possibility that SE effected the η_p^2 value for the interaction of dot-probe condition and SE group when joint, being 0.33. This result was important as a moderate effect size of 33% of the variance was accounted for by the SE and dot-probe interaction, regardless of any significance or non-significance found.

The absence of a theorized interaction effect from SE on the dot-probe condition could have been explained by mechanisms of attentional control (AC) within participants. AC has been shown to be an explicit and top-down executive process which has can be used to control the immediate and bottom-up emotional responses initiated by emotionally charged external stimuli. Derryberry, Reed, and Pilkenton-Taylor (2003) conceptualized AC as an individual's cognitive ability to engage their attention away from stimuli with a higher prepotency and dominating response, to a secondary stimulus which may be subdominal in comparison. For the current study high SE participants were assumed to have stable AC mechanisms in place to buffer against negative stimuli. However, low SE participants may have had a more mixed array of AC levels as their attention control capabilities could be assumed to have diminished at different rates throughout their formation of low SE.

For the prefrontal and frontocentral regions, there may have been a confounding AC element in the medial prefrontal cortices where the regions were located. The mPFC has been reported as important in the activation of AC when responding to threatening stimuli (Barbas et al., 2003). This may be explained by its strong link to the ventral amygdalofugal pathways as they have been shown to provide direct influence from the amygdala onto the mPFC when processing emotion and emotional expression. Additionally, the Anterior Cingulate Cortex (ACC; Mathews, Yiend & Lawrence, 2004), has significant involvement of AC, and also has influence on the mPFC as it has been shown to be significantly connected with the prefrontal cortex (Cardinal, Parkinson, Hall, & Everitt, 2002). The ACC is an area of the brain associated with emotional control, and is a primary area associated with executive functioning, being the location of higher functioning processes which are needed for AC to be effectively implemented. Gyurak, Hooker, Mikyakawa, Luerssen, and Ayduk (2012) stated that SE and AC have been localized to the rostral region of the ACC. They suggested that rACC activation underlined the buffering effect against negative stimuli, from the deployment of AC when SE is threatened by social rejection. Overall, research which has investigated the source of AC has consistently suggested prefrontal regions were associated.

The previous research into AC suggested it had the capability to override the extent to which an individual is receptive to emotional stimuli, and has been related to significantly faster disengagement from negative stimuli (Derryberry & Reed, 2002) in clinically anxious individuals. It has been shown to be a defensive mechanism for vulnerable individuals with low SE when presented with some form of negative stimuli, such as rejection (Gyurak & Ayduk, 2007). Furthermore, it has been shown to buffer heightened reactivity in response to rejection within individuals with low SE, and after an induced negative mood it could significantly decrease an individual's negative affect (Compton, 2000). These studies helped to reveal the facilitating role of AC in disengagement from threatening information, which highlighted its significance in improving an individual’s emotional well-being when adequate levels are present. This meant the confounding role of AC in ABM with individuals with various SE levels may be a possible justification for the similar amplitudes found. The activations from stimuli for the different groups in this study may have been inclusive of AC mechanisms which were unaccounted for. Consequently it was suggested that the participant’s dispositions in this study were not sufficiently measured.

An improvement would have been to include the Attentional Control Scale (ACS; Derryberry & Reed, 2002). The ACS was designed to assess the individual’s general capacity to control their attention. It used a four-point scale; 1= never, 2=sometimes, 3=often, 4= always, and is a 20-item scale. Eleven of these items have reverse scores. The scale measured two inter-related aspects of AC, the individual’s cognitive ability to shift attention from one stimulus to another, and the ability to focus attention on one or more stimuli. High ACS scores representing a greater ability in AC and low ACS scores indicating a lower ability to control attention. The ACS has been considered an index for the executive function of the anterior attentional system (see Olafson et al, 2011), and has been used in a variety of studies as an index of attentional control (Derryberry, 2002; Gyurak & Ayduk, 2007). If the ACS was used in the current study, the strength of effect of AC between each SE group would have been measured and included in the analysis of findings. Another way to reduce the confounding effects of AC would have been to compare clinical and non-clinical samples with standard and ABM attention training tasks. This would have reduced the presence of AC within the clinical group, as their AC could be inferred to be significantly reduced due to the formation of the pertaining resilient clinical disorder. Therefore, via the ACS, AC levels could be a contrasting measure between groups to prevent it from interacting with other variables.

5.3.4 Within-Subjects Factors

In the three regions of interest in this study, each showed in their post-hoc test that amplitude significantly differed when comparing the mean values from the epoch of 200 - 280ms, to the mean values from the epoch of 320 - 400ms after stimulus response. This finding suggested that participants' cognitive processes of the stimuli had significant change from an average of 240ms when compared to an average of 360ms. By referring back to descriptive values, it was shown that all three regions of interest thus significantly decreases amplitude between the two time windows (see Table 4). One potential cause may have been due to the initial response to the valence of the stimuli. When exposed to emotional stimuli, sensory responses have been shown to increase in neuronal activation as early cortical pathways are modulated by the stimuli, in both frontal and parietal regions (Vuilleumier & Driver, 2007; Vuilleumier & Huang, 2009). These modulations from the stimuli were viewed as positive amplitudes in the first epoch, in initial response to the stimuli, but decreased as the modulation reduced. With inclusion for the main effect of SE, there was a significant effect of time and SE on amplitude for participants, but only in the prefrontal line, as figure 14 highlights the effect that time had on amplitude in high and low SE groups after stimulus response.

This result suggested that when viewing the interactions, high and low SE participants had different amplitudes over the three time periods. To supplement the p-value and enabled a more detailed comparison with similar studies, the observed power was considered. The observed power has been show to test the likelihood of a statistically significant production. Although performed after the experiment in this study and named a retrospective power, the power value gained would still have been the same if calculated before the experiment (O’Keefe, 2007). It could be useful when comparing power to other results with similar criterion, as the fixed values of the significance criteria, equal sample size, and the population effect size found, can determine observed power in any study (Cohen, 1988). The resultant power for the significant difference in SE groups between the epochs in the prefrontal line was r=0.64. This was unlike smaller powers in the frontocentral (r=0.16) and centroparietal z line (r=0.08). The larger power size for the prefrontal line was due to the high correspondence between the significant p-value (.026), as p-values always suppose higher observed power (Hoenig & Heisey, 2001). Previous research with significant values below the alpha level (0.05), and effect sizes around .3 in sample sizes of around 40 participants (Osinsky et al, 2014; Wells & Beever, 2010) therefore have observed powers at around the .4 mark. The observed power in the current study showed that this study also had a good chance of finding statistically significant results in terms of effect of time on participants' amplitudes, based on the sample size, effect size, and significance value.

5.4 Other Limitations

5.4.1 Analysis of Incorrect Responses

As there was a limited amount of participant in this study, there was a very limited amount of incorrect answers in both dot-probe conditions. If there were more participants then there may have been enough occurrences of errors to be able to be investigated. In both dot-probe conditions, participants committed errors in their response to the appearance of the probe, however due to the relative ease of the task, it was posited, and found, that very few errors were made.

Only 5 participants in the standard condition, and only 4 participants in the ABM condition made enough errors that were able to be comparatively investigated further. Therefore the neurological differences in relation to the incorrect and correct responses of participants between both dot-probe conditions could not be compared in this study. Future research could improve on this limitation and investigate into the neurological effects of ABM between high and low SE groups, when erroneous responses are given. Indeed, if correct and incorrect trial responses are compared by contrasting the ERP waveform elicited in error trials with the ERP waveform elicited on correct trials then the sources of the physiological response after detection of the error may be uncovered (Gehring, Liu, Orr, & Carp, 2012). This may be useful for studies in attention as an ERP termed the error related negativity (ERN) has been suggested to have the ability to improve task performance by signalling the need to increase cognitive control if a mistake has been made (Holroyd & Coles, 2002; Botvinick, Braver, Barch, Carter, & Cohen, 2001). It has recently been uncovered as being related to the adjustment of motivational and individual variables, and has been shown to reflect differences in each individual's subjective value of errors, based upon their personality, context, and history of learning (Hajcak, 2012; Olvet & Hajcak, 2008; Weinberg, Reisel, & Hajcak, 2012). As the ERN has been found to be heightened in individuals with depression, anxiety, or in young adults with a feeling of general negative affect (Hajcak, McDonald, & Simons, 2004), future ABM research could investigate how to manipulate the ERN to adjusts cognitive control, which this study was not able to consider due to lack of participant errors.

5.4.2 Stimuli Used

Many studies used the IAPS (Lang, Bradley, & Cuthbert, 2008) in ABM investigation, however words were used instead of pictures in this study. As previously mentioned, the limited findings of ERP's may have been influenced by the use of this type of stimuli. Ishii et al (2012) noted that words might arouse lesser emotion compared with emotional pictures, which to a certain degree may have caused smaller ERP effects evident in the current study (see section 5.1.1). However, this research area has been mixed as there has been suggestions of remarkable similarity between words and pictures in regards to their effects on the same ERP components across various temporal processing stages. Emotional words have been shown to elicit a N170 component which has a comparable latency to the face-sensitive N170 found in faces (Sott et al, 2009).

Emotional words and faces have been shown to similarly modulate the early LPP occurring around 400ms which has been shown to code the intensity or level of arousal in both types of stimuli (Olofsson et al, 2008; Herbert et al, 2008; Schacht & Sommer, 2009). Therefore the properties of the words used in this study, taken from Warriner, Kuperman, and Brysbaert (2013) firstly needed to be investigated further before usage, as is was unknown if certain words had similar/less effects on ERP response as pictures. Secondly, if words were not as effective in terms of valence and self-relevance, then pictures may have been more suitable in aiding this study to examine the effects of SE and dot-probe training.

5.4.3 Single Session Application

One limitation in this study was shown when comparing its success in comparison to the success of other studies with more than one training session. Hakamata et al. (2010) found that number of sessions moderated effects on attention, with Hallion and Ruscio (2011) also attaining this trend for emotional outcomes. Furthermore, Beard et al (2012) provided support that multiple sessions helped to obtain large and more reliable effects on the individual's attention. They delivered 15 ABM training sessions for participants and found a much larger effect size from multiple sessions, providing further support for a dose-response relationship. The present study only comprised of a single session of attentional training with a non-clinical sample. This was chosen in part due to the limited time available however some studies have shown success with a single session of attentional training (Blaut et al, 2013; Osinsky et al, 2014) although not with neurological measures. Beard et al (2012) stated it was clear that future ABM studies should include comparisons of single and multiple sessions in order to obtain differences between effects on attention and subjective experience. Additionally, Osinsky et al (2014) added that future ERP or fMRI studies on the neurocognitive effects of ABM should may therefore apply a multisession design. The limited findings in this study supported this point, as more training was needed to investigate a longer time range into the effects of training attention.

5.5 Advantages

5.5.1 Neurological measures

Although providing different results which did not support the CCBH theory, this study improved methodology in comparison to Blaut et al (2013) and indeed many other studies, as a 256-channel EEG was incorporated in this experiment. This provided the opportunity to view the changes of neural trajectories and provided the opportunity to separate the events of attention into selected epochs for comparison. This improved on the limitations in Blaut et al (2013) as behavioural measures before and after training were analysed however were based on the combinative effect of all the combined modalities of attention, interpretation, and memory. Indeed, similar EEG studies were less accurate compared to the current study as their equipment had reduced spatial sampling accuracy.

Although different source localization algorithms have been successfully implemented, with correct source localization techniques acquired with as little as 30 electrodes, in more complex situations a denser sampling of spatial frequencies may be required. This may be necessary if an improved resolution of the topographical features is needed to investigate the chosen phenomena. However, if an electrode intersensor distance is greater than 2 cm in EEG sampling, then information may be lost. This has been calculated to ideally represent a high density 500-channel EEG over the head's average surface. Nevertheless, a 256–channel sampling dEEG has significant spatial sampling accuracy to enable medical grade usage as minimal information is lost. This means that unlike previous versions used in past studies, a 256-channel dEEG is sufficient to not only localize brain pathology but also detect it (Holmes, 2008). Additionally, due to the combination of high temporal and spatial resolution, the 256-channel EEG used in this study has excellent spatial resolution in a two dimensional space (see figure 7). This has overcome the previous limitations of conventional EEG; being the inability to detect ERP's present in other areas beside the brain region limited to near the skull.

5.5.2 Input Equipment

On a key press, standard keyboards have multiple signals as their contacts open and close; a bounce of the contact, then another contact as the bounce ends, then a bounce back and so forth which could cause desynchronisation in the system (see 3.1.5 Clock Synchronisation). One alternative input device called a serial response box was a potential device to use as it had benefits over a standard keyboard for this experiment. A serial response box can feature a 0 millisecond debounce period. This meant that only one digital signal can be made within a given time, usually less than 1 millisecond, which can be used for both the opening and closing of a contact in the response box. A serial response box could have been used to reduce chance of desynchronisation, however with NetStation 4.5.1 and EEG usage in this study, participants' responses were able to be verified and time stamped with the use of clock synchronisation software. The NetStation 4.5.1 system was able to establish the time difference between key press and the system log of the press and include the delay in analysis to uphold event synchronisation with no implications on the results obtained. Furthermore, a device that all participants could be comfortable using was important as they needed to reduce delays in response when using the input device. Therefore although a serial response box may have had benefits of less signal delay, a keyboard was used in this study, as its time delay was incorporated into the analysis, in addition to the probability of being more familiar for participants in comparison to new or different equipment that may have hindered their capability to respond in the tasks.

5.6 Future Research

From the mixed findings in this literature review, the results of this study suggest future research should consider revising the optimal procedure when intending to attenuate attention to negative stimuli. Previous methodologies have used a plethora of different tasks, each with their own stimuli. Although this study alongside many other have used the modified dot-probe task as defined by Matthews, MacLeoad, and Tata (1986) and different stimuli within it, it should be noted that some studies which have modified the dot-probe task based on theoretical improvements in attention modification, have had greater success than the original paradigm (Clarke, Notebaert, & MacLeod, 2014). One recent successful alternative delivery is through computerization (Yang, Ding, Dai, Peng, & Zhang, 2014; Enock, Hoffman, & McNally, 2014). It has been shown there are many potential benefits to utilizing ABM for computerised delivery, for example there would be no therapist contact, which in turn would provide a less expensive form of therapy in comparison to current methods. The review of optimal procedure when intending to attenuate attention to negative stimuli would help to standardise the stimuli used in future studies, as many use custom stimuli which have not been analysed to control for confounding factors which may distort the intended measurements.

5.7 Conclusion

This study intended to control and modify the theorised five steps within the EMER theory (Todd et al., 2012) with the goal to modifying emotional and attentional response. The five steps in the EMER represented the linear processes which were necessary to facilitate the modification of an unfolding emotional response (Gross, Sheppes, & Urry, 2011). These were to influence the situation (i.e. a dot-probe task), to change a relevant aspect of the situation (i.e. standard vs ABM tasks), to influence which portion of the stimuli was perceived (i.e. training attention to the neutral words), and to alter the cognitive representations of the situation (measured by word recall and ERP findings).

Defining the mechanisms of attentional change described by the EMER theory, it specified how upon stimuli perception, the processes that can identify whether regulation is required, are activated. If this regulation occurs, then other processes involved in attentional control are launched. Applied to this study, ABM was performed with participants to change these particular emotional regulation strategies, as measured by ERP changes and behavioural measures. Due to the resultant weakness of the ABM findings, the subsequent evaluations of the stimuli were not able to be reprocessed in order to shape the participants evaluation-based affect-biased attention filter (see figure 1). Post-stimuli attentional processes were only partially found to improve at the neurological level, and limited to the prefrontal region of interest. The findings did not support the theory of EMER itself and were in concurrence with Eysenk and Keane (2015), as the results of the current study also suggested that the interconnections of common underlying mechanisms remain to be identified, in terms of attentional manipulation. This study added to the literature which also did not replicate ABM delivery (Roberts, Hart, & Eastwood, 2010; Julian, Beard, Schmidt, Powers, & Smits, 2012; Rapee et al., 2013). Two potential factors which were unaccounted for were the effects of individual capacities of attentional control, and the large regional distribution that processes of SE are diversely performed in. Indeed, Chavez and Heatherton (2014) suggested the divided literature regarding SE may be due to the phenomenon that SE is distributed over multiple brain regions and different forms of SE are the result of the integration of the different information available in each system.

Further limitations for the effects of SE were apparent. This study tested the dependence of memory on differing SE levels in theoretically distinct attentional mechanisms when viewing negative and neutral valence words. Repeated measures and multivariate ANOVA revealed no significant effects of SE on response times to probes in either congruent or incongruent location, no effect on neurological deployment in response to negative compared to neutral stimuli, thus no dependency of memory was able to be found. These results were unable to lend support to the CCBH (Everaert et al, 2014) as no significant findings in attentional biases lead to the inability to postulate relation with memory bias, only state that neither processes were affected by dot-probe task or SE level. This did not mean the CCBH had less strength in its underpinning assumptions, but that the current study was unable to apply the assumptions of the CCBH as there were insufficient changes in the modalities of memory and attention to deliberate the links between involved mechanisms.

Although SE has had a popular appeal and clinical relevance in ABM research, most studies provide insight in the links between SE and social rejection, however, as in the current study, there has been difficulty in understanding the more general systems underlying SE in a context excluding social rejection (Chavez & Heatherton, 2014). The progressive contribution from the development of a new battery of ABM procedure may be able to have a broader influence across more stages of emotional regulation in those which would benefit from alleviating biases in attention towards negative stimuli. Methodical studies delving into the neural systems which give rise to SE, are markedly rare in the field of neurocognition (Mitchell, 2009) and further research into this area could help to create new attentional training procedures that are guided by better understandings of the mechanisms of the self, and depression or anxiety related structures through which ABM can help to regulate their effects on emotion.

6 References

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Figure 1: Research plan referee report

School of Human and Health Sciences

POSTGRADUATE RESEARCH

PROGRESSION MONITORING
RESEARCH PLAN REFEREE REPORT

Student Name:	Matthew Pears
Referee Name:	David Peebles

Delete as applicable

1.	**Is the problem to be addressed appropriate for a higher degree by research?**	**Yes**
	Comments:	
2.	**Are the aims of the investigation clearly stated and credible?**	**Yes**
	Comments:	
3.	**Has its relevance to previous work been adequately demonstrated?**	**Yes**
	Comments:	
4.	**Does the description of the work demonstrate how the aims of the study are to be achieved and that the methods used are feasible and appropriate?**	**Yes**
	Comments:	
5.	**Does the title of the project adequately describe the field of investigation in question?**	**Yes**
	Comments:	
6.	**Is the timescale envisaged realistic?**	**Yes**
	Comments:	
7.	**Is the scope and depth of the investigation appropriate for the programme enrolled on (MPhil/Phd or PhD direct)?**	**Yes**
	Comments:	
8.	**If it is an application for MPhil with possible transfer to PhD, does it show how the project would develop to be appropriate for the award of a PhD, but also indicate where the MPhil stage could end if necessary?**	**N/A**
	Comments:	
9.	**Has a suitable collaborating establishment been cited and are the arrangements envisaged for collaboration satisfactory?**	**No**
	Comments:	
10.	**Have any ethical issues been clearly identified and addressed?**	**Yes**
	Comments:	
11.	**Has SREP advice been sought?**	**Yes**
	Comments:	
12.	**Has SREP approval been given?**	**No**
	Comments: The application is currently being reviewed	
13.	**Are there adequate facilities and equipment available to support the project, and can necessary access to information be obtained?**	**Yes**

POSTGRADUATE RESEARCH

PROGRESSION MONITORING
RESEARCH PLAN REFEREE REPORT

14.	**Is the programme of supporting studies appropriate both for the background of the candidate and for the project to be undertaken, and is it expressed in specific, rather than general terms?**	**Yes**
	Comments:	
15.	**Do you have any further concerns about the quality of the research proposal?**	**No**
	Comments:	
16.	**Do you have any further concerns about the proposed research?**	**No**
	Comments:	
17.	**Do you think there is cause for concern about the quality of the guidance the student may have been receiving from the supervisor(s)?**	**No**
	Comments:	
18.	**Do you have any advice to offer the student and / or supervisors?** **(if yes, please give details)**	**No**
	Comments: This is a well written and researched plan. Matthew has demonstrated a good grasp of the problem and the previous literature and has justified his study well. The proposed experiment is sufficiently novel and has the appropriate technical and theoretical merit for the degree level. My only concern is that it may be difficult to find enough participants from a 'normal' population who have sufficiently low levels of self esteem to obtain the desired effect. In addition, the ethical issues related to the project will need to be considered carefully (but this will no doubt be addressed by the SREP process). Otherwise, I think the plan is well conceived and designed and has a good chance of being successful. David Peebles	

Signed: (Referee)	David Peebles	**Date:**	26/03/2014

Completed Form to be returned to Kirsty Thomson
k.thomson@hud.ac.uk
School Research Office – HHRG/01

Figure 2: School research ethics panel supervisors report

THE UNIVERSITY OF HUDDERSFIELD
SCHOOL OF HUMAN AND HEALTH SCIENCES – SCHOOL RESEARCH ETHICS PANEL

SUPERVISOR REPORT

Please complete and return via email to:
Kirsty Thomson SREP Administrator: hhs_srep@hud.ac.uk

Name of student: Matthew John Pears

Title of study: The Causal Relationship between Attentional Manipulation and Memory Bias: Varying Self-Esteem and ERP Findings.

Name of course (if not MPhil or PhD): Masters by Research (MRes)

Name of supervisor(s): Dr Simon Goodson

Date: 27/02/2014

I confirm that I have (a) read all documentation submitted to SREP in respect of the above research project and (b) support its submission to SREP. I also confirm that a Risk Analysis has been conducted in accordance with University requirements.

Please identify all documents seen below:

Letters (specify)	
Participant information sheet	Yes
Participant consent form	Yes
Interview schedule	NA
Questionnaire	NA
NHS REC form	NA
University of Huddersfield Risk Analysis and Management form	Yes
Other	

Signed (if submitting hard copy):

S. Goodson

Please note:

No application submitted by a student will be considered by SREP without a fully completed Supervisor Report

If you have any queries relating to the completion of this form or need any other information relating to SREP's consideration of this proposal, please email hhs_srep@hud.ac.uk

THE UNIVERSITY OF HUDDERSFIELD
School of Human and Health Sciences – School Research Ethics Panel

OUTLINE OF PROPOSAL
Please complete and return via email to:
Kirsty Thomson SREP Administrator: hhs_srep@hud.ac.uk

Name of applicant: Matthew John Pears

Title of study: The Causal Relationship between Attentional Manipulation and Memory Bias: Varying Self-Esteem and ERP Findings.

Department: Psychology

Date sent: 07/03/2014

Issue	Please provide sufficient detail for SREP to assess strategies used to address ethical issues in the research proposal
Researcher(s) details	Matthew Pears, 2 Blackburn Croft, Sheffield, S35 2ZJ, 07456 142142
Supervisor details	Dr Simon Goodson, Senior Lecturer in Psychology, Ramsden Building R2/41, Queensgate Huddersfield, HD1 3DH, 01484 473173
Aim / objectives	The objective is to uncover the causal relation between attentional bias and memory bias in low self-esteem individuals, through applying attentional manipulation techniques. The second objective is to uncover the electrophysiological differences in attention between individuals with low and high self-esteem levels, and how these change from the application of attentional manipulation.
Brief overview of research methodology	Three tasks will be programmed in E-prime 2. The first task has two variations; one is a standard attentional probe, or dot-probe, task. The second variation is a modified dot-probe task, implementing attentional training. The second task is a word recall task; this is a memory task consisting of 20 words presented individually for 8 seconds. The third task is a filler task to reduce the priming effects from the memory task; this will be called the Priming Effect Reduction Task (P.E.R.T). One participant will be examined per session, as only one EEG machine supports 256 channel electrode arrangements. Participants will have either normal or corrected to normal vision. They will meet in the computer lab which supports the EEG equipment. They will be sat in front on a 22" monitor approximately 100 cm away from the screen. They will have a response pad consisting of two buttons that they will press to appropriately respond within the tests described above. Participants would be informed that the experiment is related to memory and attention, briefing them without giving away the full purpose and hypotheses of the study as to avoid desirability effects. A consent form will be signed before they proceed with the experiment. The EEG equipment is being fitted by EEG technicians then verbal instructions will be given on how to complete each task. Instructions will be given for each task in full again briefly before each task starts later on. Once they are ready, each participant will then complete the dot-probe task. This requires participants to view two words at once on the computer screen, and response to the direction of an arrow presented after these words, by pressing on the response box buttons. The experimenter will briefly go through the instructions for the memory task. Participants will then carry out the memory task. After this, the instructions for the P.E.R.T Task will be stated, and participants will be given three minutes to perform this task. Finally, participants will be asked to type down as many words as possible that they can remember from the memory task. There will be a five minute time limit for this task. A full debrief will be provided with names and contact details for relevant support if any questions are raised.
Study Start & End Date	Start Date: Oct 2013 End Date: Oct 2014
Permissions for study	Lecturers will be asked/ informed of the study by email, and will be asked if the researcher has permission to enter near the end of their lecture to talk to students. If permission is granted, the researcher will go to the lecture and recruit participants within the granted timeframe by verbally informing the students about the experiment and asking if they would like to participate.
Access to participants	Participants will be from the University of Huddersfield and aged 18+. They will be from any department and school within the University. Within their lecture, students will be verbally informed of the study and its aims. If individuals are interested by show of hand, they will be given an information sheet which includes contact details and a brief overview of the study. Those who wish to volunteer will emailed the researcher, and will firstly be asked about compatibility for the experiment regarding EEG usage (i.e. epilepsy, eye sight, claustrophobia, dyslexia, and other health issues). Then, participants will be emailed to arrange meeting times and sent the Rosenberg self-esteem scale to fill in. Participants will be

	required to meet the criteria of having either low or high self-esteem as measured by the RSES. From there, meetings will be arranged to collect data within the University. Participant age, sex, and RSES scores will be gathered.
Confidentiality	Participants' information will be confidential and a limited number of individuals will be able access data (1st and 2nd markers, and an external examiner). The raw data (questionnaire scores, EEG data and test results) will be encrypted and kept on a password protected computer. With the codes/passwords kept on another password secure computer away from the raw data. Identifying (names, places) or signifying (history, hobbies) words will been extracted from the data to increase anonymity of participants. Data will be destroyed 5 years after the completion of the researcher's course at Huddersfield University, in accordance with their regulations. Data will be destroyed by shredding of all physical material, and permanent deletion of all saved electronic data.
Anonymity	Full anonymity of participants will be implemented throughout the entire length of the study. No identifying or signifying data will be collected which may risk the anonymity of the individual. Finished work will have complete anonymity for all participants. Published and/or unpublished work will also anonymise participants.
Psychological support for participants	During their involvement, participants can communicate with the researcher at any time if they need to, via email, meetings, or telephone. From the start of contact, participants will have an information sheet to refer to. After the experiment, participants can openly ask questions and will be able to contact the researcher at any time. A debriefing form with names and contact details for relevant support will be given to participants. This includes the contact details for my supervisor and I.
Researcher safety / support (attach complete University Risk Analysis and Management form)	Researcher safety can be maintained by informing the supervisor of any intended meetings with participants, and remaining in the University's facilities whilst meeting individuals to collect data. Telephone contact can be made between the researcher and the supervisor if any issues arise. Researcher support is by email, telephone and one-to-one meetings agreed by the researcher and supervisor.
Identify any potential conflicts of interest	There are no potential conflicts of interest.
Please supply copies of all relevant supporting documentation electronically. If this is not available electronically, please provide explanation and supply hard copy	
Information sheet	Information sheet attached, see page 6. Additionally, a debriefing form is attached, see page 8.
Consent form	Consent form attached, see page 5.
Letters	Email to participants attached, see page 4.
Questionnaires	The Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965; 1989) will be used. The RSES is a self-report inventory consisting of ten items rated on a four point scale assessing current state self-esteem symptoms. This questionnaire has good reliability and validity in both healthy and subclinical samples (Robins, 2001). More specifically, the RSE shows strong internal consistency and test-retest reliability (Blascovich &Tomaka, 1991; Robins, Trzesniewski et al., 2002). It also has reliable findings of convergent validity with other measures of global self-esteem (Zeigler-Hill, 2010) at a range from .63 to .90. Important for this study, is that the RSE also shows thorough discriminant validity in reference to other measures, such as with academic outcomes, satisfaction in life, and short/long term optimism (Robins et al., 2001; Sowislo & Orth, 2013).
Interview guide	This will be discussed per individual, to find a time that suits them. If they do not feel comfortable with any dates or times they will be able to change/cancel at anytime with or without notice.
Dissemination of results	Results of the study will be available to all participants. Participants will be asked if they would like a copy of the final results. The results may be available at Huddersfield Library for others to view.
Other issues	If any appropriate conferences arise, the researcher would like to arrange for this work to be presented at conferences. This will be discussed with the main supervisor.
Where application is to be made to NHS Research Ethics Committee / External Agencies	Not Applicable
All documentation has been read by supervisor (where applicable)	Please confirm. This proposal will not be considered unless the supervisor has submitted a report confirming that (s)he has read all documents and supports their submission to SREP

All documentation must be submitted to the SREP administrator. All proposals will be reviewed by two members of SREP.

If you have any queries relating to the completion of this form or any other queries relating to SREP's consideration of this proposal, please contact the SREP administrator (Kirsty Thomson) in the first instance – hhs_srep@hud.ac.uk

Figure 3: SREP Approval E-Mail

Your SREP Application - Matthew Pears - MSc by Res Student - APPROVED (with point for consideration) - The Causal Relationship between Attentional Manipulation and Memory Bias: Varying Self-Esteem and ERP Findings (SREP/2014/024)

Kirsty Thomson

To: Matthew Pears U1060192

Cc: Simon Goodson; Karen Ousey; Jane Tobbell

Inbox 07 April 2014 15:14

Dear Matt,

Dr Karen Ousey, Chair of SREP, has asked me to contact you with regard to your SREP application as detailed above.

Your application has been approved outright.

However, the reviewers of your application made the following comment (for your consideration):

‘If we have understood this correctly, participants will be classified as having either 'high' or 'low' self-esteem before they do the experiment and the experimenter will know the group each participant is in. Although there is some information about the self-esteem scale in the information sheet, what will happen if a participant asks about their self-esteem score? Will this information be withheld? If so, might it not be more useful to let them know and give them more information about the notion of self-esteem in the debrief sheet (and reassure people in the low self-esteem group)?’

With best wishes for the success of your research project.

Regards,

Kirsty

(on behalf of Dr Karen Ousey, Chair of SREP)

Kirsty Thomson
Research Administrator

Figure 4: Email to Participants

Hello,

My name is Matthew Pears - I am a Master by Research (MRes) Psychology student undertaking my research project entitled:

‘The Causal Relationship between Attentional Manipulation and Memory Bias: Varying Self-Esteem and ERP Findings’.

I would like to ask for 45 minutes of your time to help me with my research.
It involves a few tasks into your attention when presented with specific words, with EEG equipment worn by you for one of these tasks (approximately 10 minutes).
If you are aged 18+, and feel you may be able to help with this project please reply to me at U1060192@hud.ac.uk.

I would then be able to give you more details about the study and if you are still eligible to participate, we can arrange a time to carry out the experiment. The whole thing shouldn't take longer than 45 minutes and your participation would be greatly appreciated.

Participation is voluntary, anonymous and confidential. Additionally, you are free to withdraw at any time without reason.

Thank you for your help!

Matthew Pears,

U1060192@hud.ac.uk

Figure 5: Consent Form

Student: Matthew Pears **Course:** Psychology (Master of Research)

Title of Project: The Causal Relationship between Attentional Manipulation and Memory Bias: Varying Self-Esteem and ERP Findings

It is important that you read, understand and sign the consent form. Your contribution to this research is entirely voluntary and you are not obliged in any way to participate, if you require any further details please contact your researcher.

I have been fully informed of the nature and aims of this research ☐

I consent to taking part in it ☐

I understand that I have the right to withdraw from the research at any time without giving any reason ☐

I give permission for my words to be quoted (by use of pseudonym) ☐

I understand that the information collected will be kept in secure conditions for a period of five years at the University of Huddersfield ☐

I understand that no person other than the researcher/s and facilitator/s will have access to the information provided. ☐

I understand that my identity will be protected by the use of pseudonym in the report and that no written information that could lead to my being identified will be included in any report. ☐

If you are satisfied that you understand the information and are happy to take part in this project please put a tick in the box aligned to each sentence and print and sign below.

Signature of Participant: ______________	Signature of Researcher: ______________
Print: ______________	Print: ______________
Date: ______________	Date: ______________

(one copy to be retained by Participant / one copy to be retained by Researcher)

Figure 6: Participant information sheet

University of Huddersfield
Participant information sheet

This sheet is for you to keep throughout your participation. If you are unclear about the study, your role, ethics, anonymity, confidentiality etc then please refer to this sheet.

TITLE

The Causal Relationship between Attentional Manipulation and Memory Bias: Varying Self-Esteem and ERP Findings

INVITATION

You are being asked to take part in a research study run by myself, Matthew Pears, supervised by Dr Simon Goodson. This study will look into your attention to words that are either neutral or negative in valence (emotion). Also, your memory for previously viewed words will be tested.

WHAT WILL HAPPEN

In this study, you will perform four tasks. In the first task you will be shown two words at once, they will disappear and a probe will appear, you will have to press an button in response to this (discussed fully on the day). You will wear EEG equipment which will measure changes in your brain's reactions to the words displayed. The second test will show you twenty words and you will have to remember as many of these as you can. In the third test, you will be presented with either the word 'right' or 'left'. You have to press the button which represents the word on screen (i.e. left button represents the word 'left', right button represents the word 'right'). Lastly, you will write down which words you can remember from task 2.

TIME COMMITMENT

The study typically takes 40 minutes per session, and there is only one session.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied up to that point be withdrawn and destroyed. There will be no penalty for withdrawing from the experiment.
You have the right to omit or refuse to answer/respond to any question that is asked to you, without penalty. You have the right to have your questions answered, in relation to the procedures (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, please ask the researcher before the study begins. All data will be anonymous in the final project submission.

BENEFITS AND RISKS

There are no known benefits for you in this study. The risks to you in this study may come from the words presented to you in the tasks. Some of the words are strong in evoking an emotional reaction from you. This means you may become emotional by viewing these words. There is little risk with using the EEG equipment; there is a small chance of temporary skin irritation from the electrodes. Participation in this study requires the completion of a standardised test named the Rosenberg Self-Esteem Scale, which is a measure of general Self-Esteem. Scores from this test would not be a sufficient basis for clinical decisions or diagnosis, contain substantial margins of error, and are not used for diagnostic purposes in this study. It is not possible to provide feedback of individual scores to participants.

COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary. You will not receive any monetary compensation for your participation.

CONFIDENTIALITY/ANONYMITY

The data collected will contain identifying information about you. These data are your full name, age, sex, and self-esteem level. However, if there are any identifying (names, places) or signifying (history, hobbies) words, these will be extracted from the data to provide anonymity. Additionally, data is backed up in a secure, password protected and encrypted location. Data will be destroyed 5 years after the completion of the Researcher’s course at Huddersfield University, in accordance with the University's regulations. Data will be destroyed by shredding of all physical material, and permanent deletion of all saved electronic data.

FOR FURTHER INFORMATION

Dr Simon Goodson will be glad to answer your questions about this study at any time. You may contact him at: S.Goodson@hud.ac.uk. Tel: 01484 473173

If you are interested in the final results of this study, please contact Matthew Pears at u1060192@hud.ac.uk.

Figure 7: Rosenberg Self- Esteem Scale

Rosenberg Self- Esteem Scale

Participant Number: ________

What is your Age? ________

What Sex are you (F/M)? ________

Instructions:

Below is a list of statements dealing with your general feelings about yourself.

If you Strongly Agree, circle SA. If you Agree with the statement, circle A. If you Disagree, circle D. If you Strongly Disagree, circle SD.

1.	On the whole, I am satisfied with myself.	SA	A	D	SD
2.	At times, I think I am no good at all.	SA	A	D	SD
3.	I feel that I have a number of good qualities.	SA	A	D	SD
4.	I am able to do things as well as most other people.	SA	A	D	SD
5.	I feel I do not have much to be proud of.	SA	A	D	SD
6.	I certainly feel useless at times.	SA	A	D	SD
7.	I feel that I'm a person of worth, at least on an equal plane with others.	SA	A	D	SD
8.	I wish I could have more respect for myself.	SA	A	D	SD
9.	All in all, I am inclined to feel that I am a failure.	SA	A	D	SD
10.	I take a positive attitude toward myself.	SA	A	D	SD

Figure 7.5 : Beck Depression Inventory – II

Age: Sex:

Participant Number:

This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the **one statement** in each group that best describes the way you have been feeling during the **past two weeks, including today.** Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleeping Pattern) or Item 18 (Changes in Appetite).

1.

0 I do not feel sad.
1 I feel sad much of the time.
2 I am sad all the time.
3 I am so sad or unhappy that I can't stand it.

2.

0 I am not discouraged about my future.
1 I feel more discouraged about my future than I used to be.
2 I do not expect anything to work out for me.
3 I feel my future is hopeless and will only get worse.

3.

0 I do not feel like a failure.
1 I have failed more than I should have.
2 As I look back, I see a lot of failures.
3 I feel I am a total failure as a person.

4.

0 I get as much pleasure as I ever did from the things I enjoy.
1 I don't enjoy things as much as I used to.
2 I get very little pleasure from the things I do.
3 I can't get any pleasure from the things I used to enjoy.

5.

0 I don't feel particularly guilty.
1 I feel guilty over many things I have done or should have done.
2 I feel quite guilty most of the time.
3 I feel guilty all of the time.

6.

0 I don't feel I am being punished.
1 I feel I may be punished.
2 I expect to be punished.
3 I feel I am being punished.

7.

0 I feel the same about myself as ever.
1 I have lost confidence in myself.

2 I am disappointed in myself.
3 I dislike myself.

8.

0 I don’t criticize or blame myself more than usual.
1 I am more critical of myself than I used to be.
2 I criticize myself for all of my faults.
3 I blame myself for everything bad that happens.

9.

0 I don’t have any thoughts of killing myself.
1 I have thoughts of killing myself, but I would not carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.

10.

0 I don’t cry any more than I used to.
1 I cry more than I used to.
2 I cry over every little thing.
3 I feel like crying, but I can’t.

11.

0 I am no more restless or wound up than usual.
1 I feel more restless or wound up than usual.
2 I am so restless or agitated that it’s hard to stay still.
3 I am so restless or agitated that I have to keep moving or doing something.

12.

0 I have not lost interest in other people or activities
1 I am less interested in other people or things than before.
2 I have lost most of my interest in other people or things.
3 It’s hard to get interested in anything.

13.

0 I make decisions about as well as ever.
1 I find it more difficult to make decisions than usual.
2 I have much greater difficulty in making decisions than I used to.
3 I have trouble making any decisions.

14.

0 I do not feel I am worthless.
1 I don’t consider myself as worthless and useful as I used to.
2 I feel more worthless as compared to other people.
3 I feel utterly worthless

15.

0 I have as much energy as ever.
1 I have less energy than I used to have.
2 I don’t have enough energy to do very much.
3 I don’t have enough energy to do anything.

16.

0 I have not experienced any change in my sleeping pattern.
1a I sleep somewhat more than usual.
1b I sleep somewhat less than usual.
2aI sleep a lot more than usual.
2b I sleep a lot less than usual.
3a I sleep most of the day.
3b I wake up 1-2 hours early and can't get back to sleep.

17.

0 I am no more irritable than usual
1 I am more irritable than usual.
2 I am much more irritable than usual.
3 I am irritable all the time.

18.

0 I have not experienced any change in my appetite.
1aMy appetite is somewhat less than usual.
1b My appetite is somewhat greater than usual.
2a My appetite is much less than before
2b My appetite is much greater than usual.
3 I have no appetite at all.
3b I crave food all the time.

19.

0 I can concentrate as well as ever.
1 I can't concentrate as well as usual.
2 It's hard to keep my mind on anything for very long.
3 I find I can't concentrate on anything.

20.

0 I am no more tired or fatigued than usual.
1 I get more tired or fatigued more easily than usual.
2 I am too tired or fatigued to do a lot of the things I used to do.
3 I am too tired or fatigued to do most of the things I used to do.

21.

0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely.

Total score (researcher use only):

Figure 8: Delayed Free Recall Task Sheet

Delayed Free Recall Task

This task is the final task and has no time limit.

In this task, you are required to recall and write down as many words as possible from the previous task.

To remind you, in the previous task you viewed 20 words, one at a time. Please write down as many of these words as you can remember.

If you are unsure of a word, please write it down anyway. Spelling does not have to be accurate.

Participant number:

Figure 9: Debriefing form

Debriefing form

This study was concerned with your attention to words that were either neutral or negative in valence (emotion). Also, your memory was tested to see which type of words you remember more - neutral or negative.

How was this tested?

In this study, all participants performed three tasks. The first task had two groups, a control group (everything is normal) and an experimental group (something was changed slightly). If you were in the group where the probe (the arrow) was in the place of the neutral word more often than in the negative word (you may not have noticed), then you received training. This helped you to deploy more attention to the neutral words, rather than the negative words. The EEG equipment that you wore measured changes into your reactions to these types of words, to show that the attention training was working. The second test was a memory task, twenty words were shown and you had to remember as many words as you could. Lastly, you typed which words you could remember from the previous memory test. This test showed us which words you remembered, to then be analysed in relation to valence and frequency of those words you recalled.

What data were collected?

Your score on the self-esteem scale was collected. This was to decide which group you would be in. Your EEG recording was also collected. Lastly, the words you wrote were recorded, to be analysed along with each of the above data. All data is anonymous and will be destroyed 5 years after the end of the researcher's MSc course.

What if you want to know more?

If you are interested about learning more about this subject area, you can contact the following individuals:
Matthew Pears
Email Address: U1060192@hud.ac.uk
Dr Simon Goodson
Email Address: S.Goodson@hud.ac.uk

What if there are any issues?

If any issues arise, no matter how small, please contact the following individuals:
Matthew Pears
Tel: 07456 142142. Email Address: U1060192@hud.ac.uk
Dr Simon Goodson
Tel: 01484 473173. Email Address: S.Goodson@hud.ac.uk

Figure 10: General health and safety risk assessment form

UNIVERSITY OF HUDDERSFIELD - GENERAL HEALTH AND SAFETY RISK ASSESSMENT FORM
(To be completed for intended and proposed activities)

Brief description of activity: VDU use in psychology laboratories		
Location: all psychology laboratories	**Assessment by: Sarah Pearson**	**Assessment date: 18/02/14**

SPECIFIC TASK/ASPECT OF ACTIVITY: Operation of display screen equipment						
Hazards identified	**Risks to health and safety**	**People at risk**	**Measures to manage the risks effectively**	**Action by:**		
				Who	**When**	**Completed**
Computer and VDU operation	Working for prolonged periods without change of posture or sufficient break. Inappropriate layout, lack of awareness etc resulting in poor posture being adopted when using display screen equipment.	Staff and students working at display screen equipment.	Ensure staff and student awareness of the health and safety aspects of working at display screen equipment through training and/or information. The workstation and equipment is subject to the risk assessment process given within the University's specific policy for ensuring health and safety whilst working at display screen equipment.			

RISK ASSESSMENT REVIEW:

To be carried out by: Sarah Pearson	**Date when to be carried out by: 18/02/15**

UNIVERSITY OF HUDDERSFIELD - GENERAL HEALTH AND SAFETY RISK ASSESSMENT FORM

(To be completed for intended and proposed activities)

Brief description of activity: Use of dense array EEG system in biopsychology research		
Location: RB/19b	**Assessment by:** Sarah Pearson	**Assessment date:** 18/02/14

SPECIFIC TASK/ASPECT OF ACTIVITY: Application of EEG sensor net						
Hazards identified	**Risks to health and safety**	**People at risk**	**Measures to manage the risks effectively**	**Action by:**		
				Who	**When**	**Completed**

Skin sensitivity towards electrolyte conducting medium (salt water and baby shampoo)	A small minority of people may be sensitive or allergic to the conducting medium	Participants tested using the EEG sensor net	Always use the hypo-allergenic baby shampoo provided in the lab. Before beginning any study, experimenter should check that the participant is not prone to skin allergies.			

SPECIFIC TASK/ASPECT OF ACTIVITY: Disinfection of EEG sensor net

Hazards identified	Risks to health and safety	People at risk	Measures to manage the risks effectively	Action by:		
				Who	When	Completed
Skin sensitivity towards disinfection solution	A small minority of people may be sensitive or allergic to the disinfection solution	Staff and students cleaning the EEG sensor net	Always use the disinfectant specified by the manufacturer and available in the lab. Wear protective gloves if necessary whilst in contact with the disinfection solution – they are available in the lab.			

SPECIFIC TASK/ASPECT OF ACTIVITY: Use of sink in lab

Hazards identified	Risks to health and safety	People at risk	Measures to manage the risks effectively	Action by:		
				Who	When	Completed
Electrocution Water splashes onto electrical equipment	Use of electrical equipment after washing hands increases risk of electrocution. Fire Hazard/electrocution	Staff and students using the sink in the lab	Ensure that all hands are dry before using equipment. Paper towels to be provided for sessions that involve the use of sink. Ensure that electrical equipment is not too close and/or there is a physical barrier between sink and equipment.			

RISK ASSESSMENT REVIEW:

To be carried out by: Sarah Pearson	**Date when to be carried out by: 18/02/15**

UNIVERSITY OF HUDDERSFIELD - GENERAL HEALTH AND SAFETY RISK ASSESSMENT FORM

(To be completed for intended and proposed activities)

Additional Risks: none.

ACTIVITY: Data collection and writing process	Name: Matthew Pears	
Location: University of Huddersfield	**Assessment by: Matthew Pears**	**Assessment date: 18/02/14**

Hazard(s) Identified	Details of Risk(s)	People at Risk	Risk management measures	Other comments
Loss/theft of data	Security of data	Participants	Electronic data to be stored only on password protected secured computer equipment (tracking enabled) and storage devices.	Transportable electronic devices to be kept with the researcher at all times when in use. Stored in a locked draw at home or in car boot if not in use.
Manual handling	Personal wellbeing	Researcher	Carry equipment with consideration for personal health and wellbeing.	

Figure 11: Table showing descriptive statistics for negative and neutral words recalled by high and los SE participants.

Descriptives

	Self_Esteem_Group			Statistic	Std. Error
Negative_Words	High	Mean		5.20	.401
		95% Confidence Interval for Mean	Lower Bound	4.36	
			Upper Bound	6.04	
		5% Trimmed Mean		5.17	
		Median		5.00	
		Variance		3.221	
		Std. Deviation		1.795	
		Minimum		2	
		Maximum		9	
		Range		7	
		Interquartile Range		3	
		Skewness		.214	.512
		Kurtosis		.098	.992
	Low	Mean		5.30	.442
		95% Confidence Interval for Mean	Lower Bound	4.38	
			Upper Bound	6.22	
		5% Trimmed Mean		5.39	
		Median		5.50	
		Variance		3.905	
		Std. Deviation		1.976	
		Minimum		0	
		Maximum		9	
		Range		9	
		Interquartile Range		3	
		Skewness		-.647	.512
		Kurtosis		1.662	.992
Neutral_Words	High	Mean		4.20	.490
		95% Confidence Interval for Mean	Lower Bound	3.17	
			Upper Bound	5.23	
		5% Trimmed Mean		4.17	
		Median		4.00	
		Variance		4.800	
		Std. Deviation		2.191	

	Minimum		0	
	Maximum		9	
	Range		9	
	Interquartile Range		3	
	Skewness		.418	.512
	Kurtosis		.443	.992
Low	Mean		4.20	.352
	95% Confidence Interval for Mean	Lower Bound	3.46	
		Upper Bound	4.94	
	5% Trimmed Mean		4.17	
	Median		4.00	
	Variance		2.484	
	Std. Deviation		1.576	
	Minimum		2	
	Maximum		7	
	Range		5	
	Interquartile Range		3	
	Skewness		.441	.512
	Kurtosis		-.999	.992

Figure 12: Table showing the P values for the Shapiro-Wilk test of normality regarding the frequency of negative and neutral words recalled by participants in the delayed free recall task.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Self_Esteem_Group	Statistic	df	Sig.	Statistic	df	Sig.
Negative_Words	High	.194	20	.046	.947	20	.321
	Low	.155	20	.200*	.943	20	.272
Neutral_Words	High	.236	20	.005	.946	20	.315
	Low	.227	20	.008	.903	20	.047

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 13: Histogram showing approximate shape of a normal curve for low SE participants, this suggested normal distribution for the group.

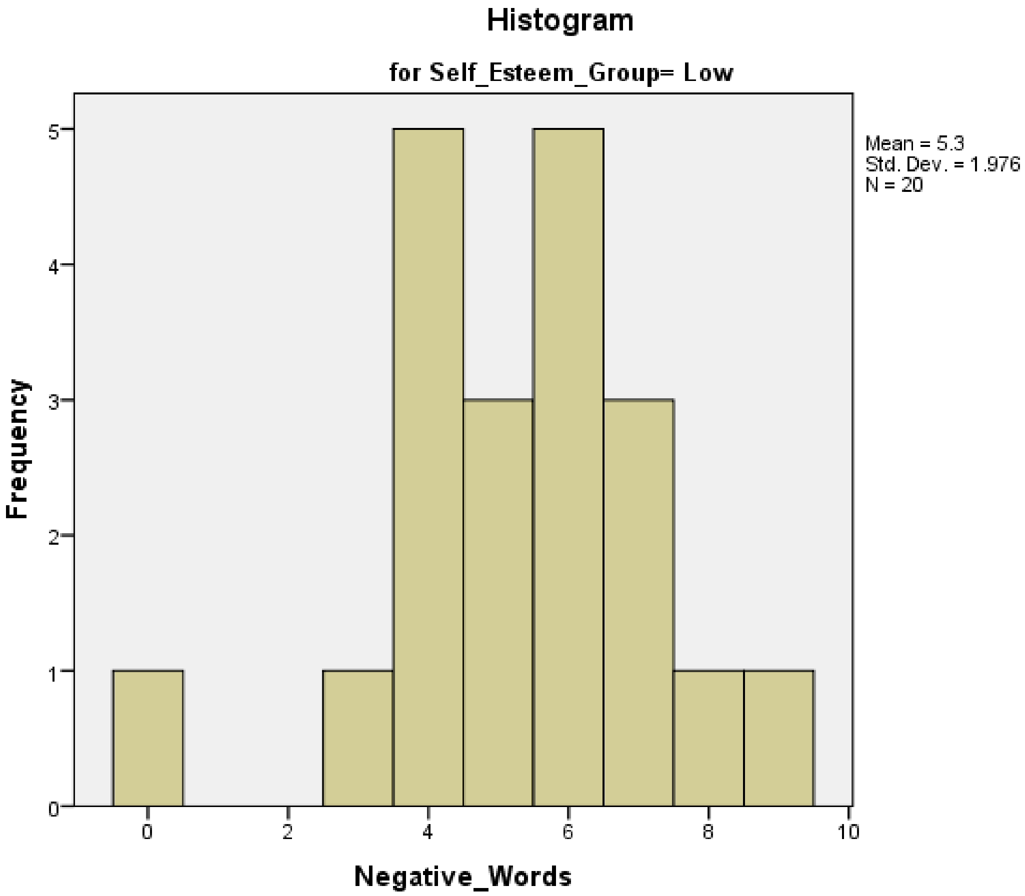


Figure 14: Histogram showing approximate shape of a normal curve for high SE participants, this suggested normal distribution for the group.

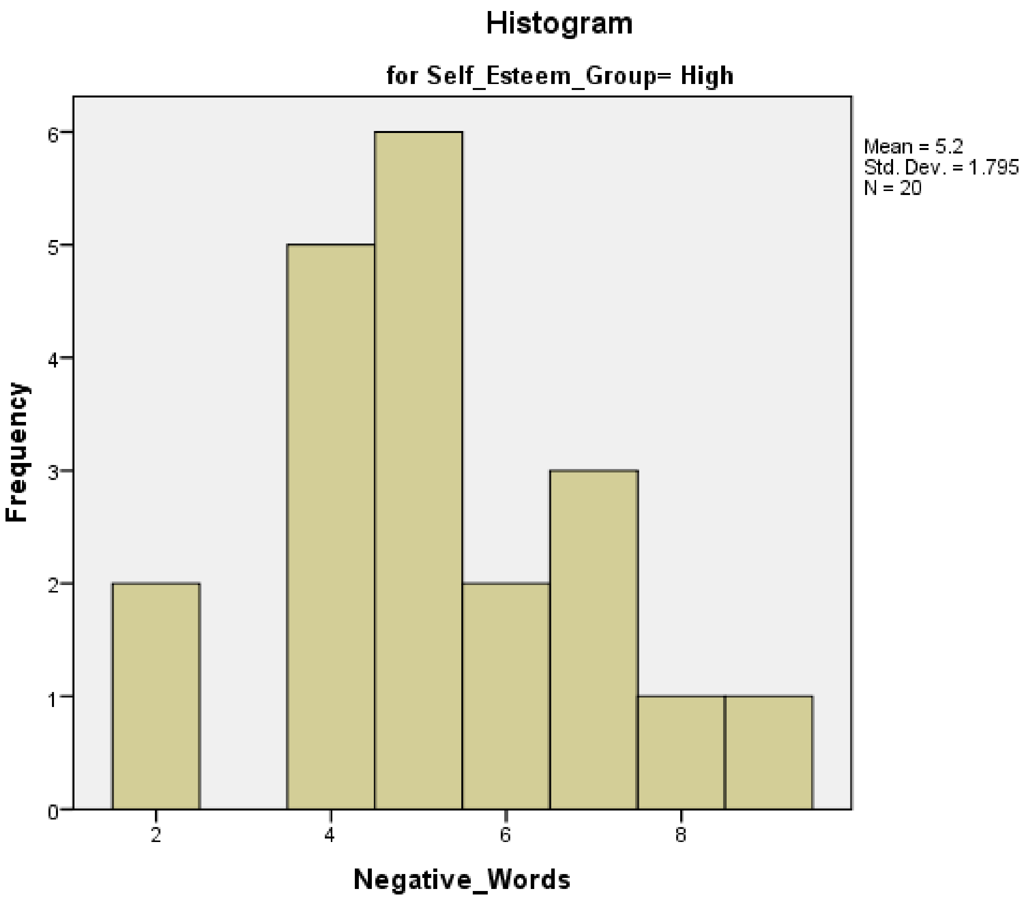


Figure 15: Q-Q plot of negative words for high SE participants showing data fell within the estimated line of normality.

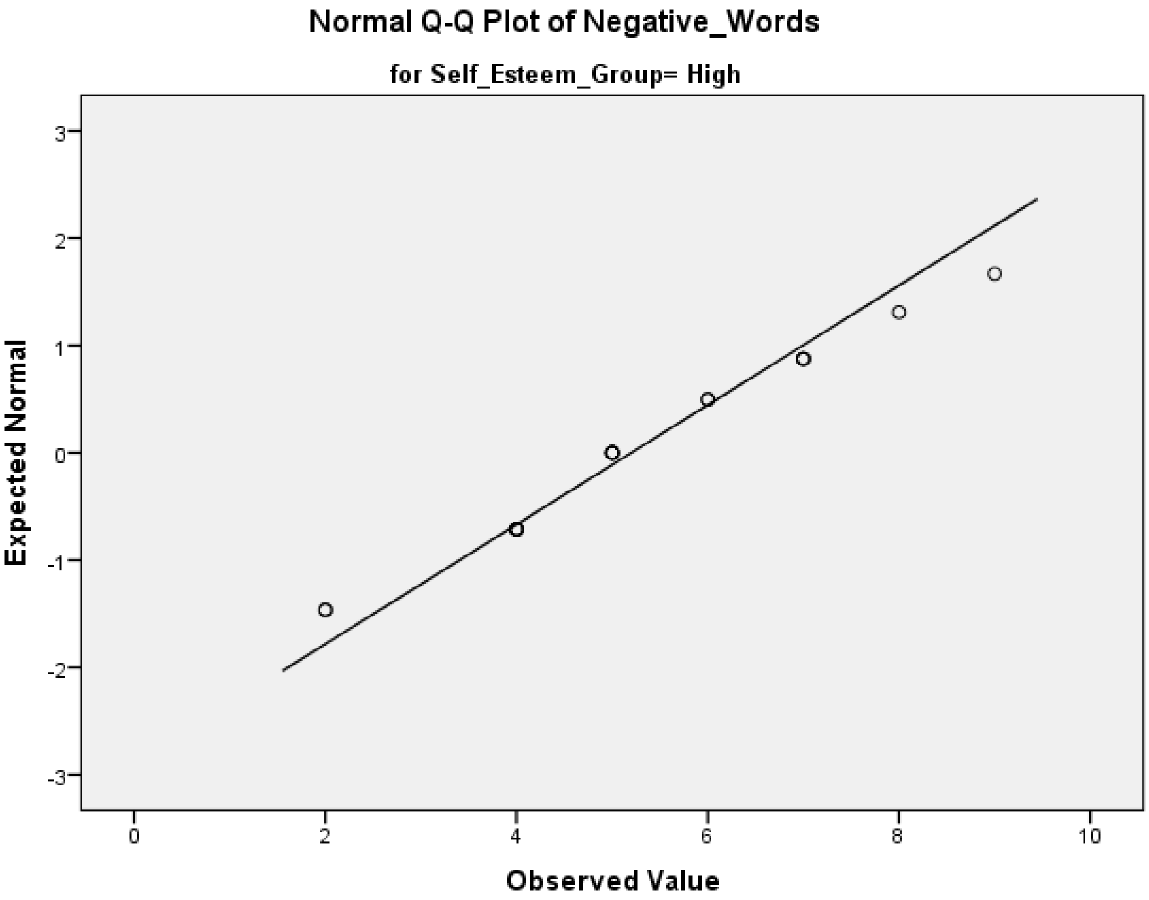


Figure 16: Q-Q plot of negative words for low SE participants showing data fell within the estimated line of normality.

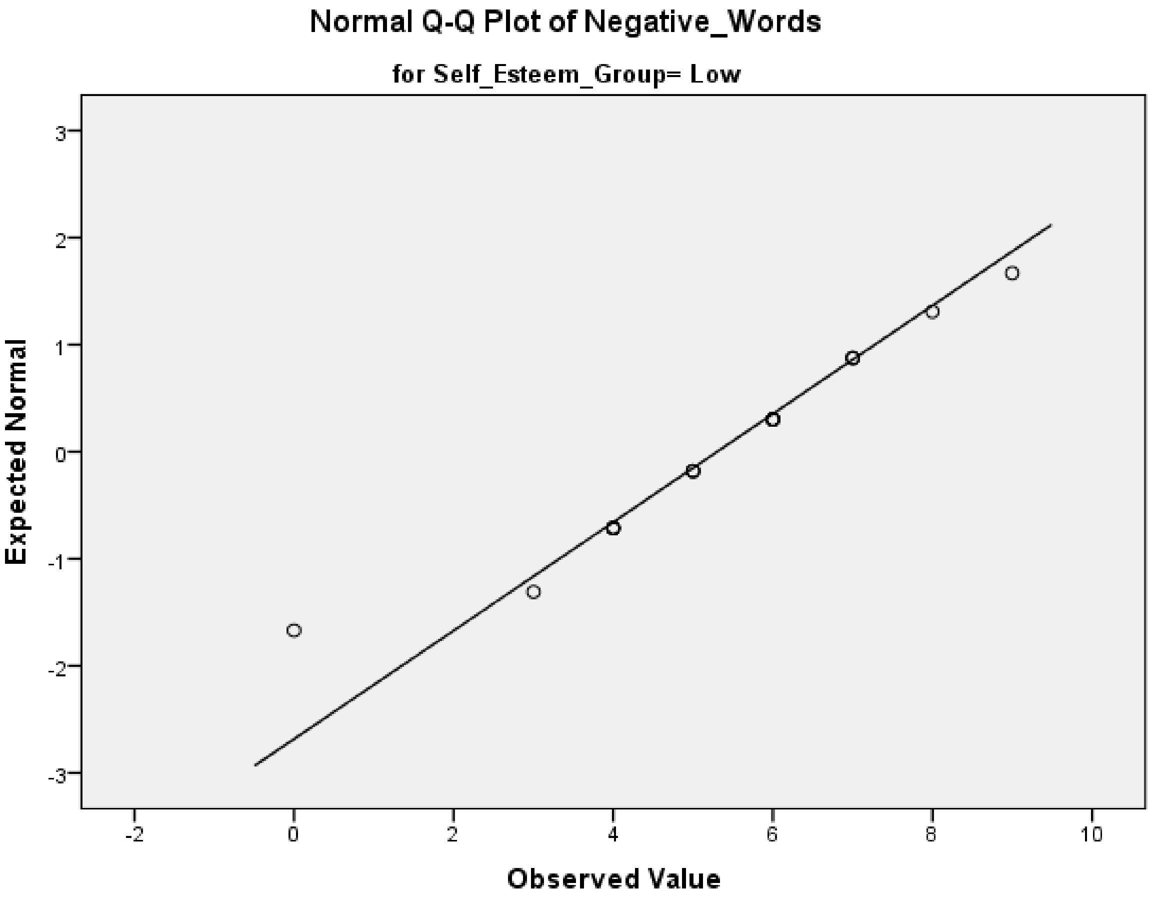


Figure 17: Box plot showing the outlying times for participants (2, 5, 6, and 11) in relation to attentional response scores

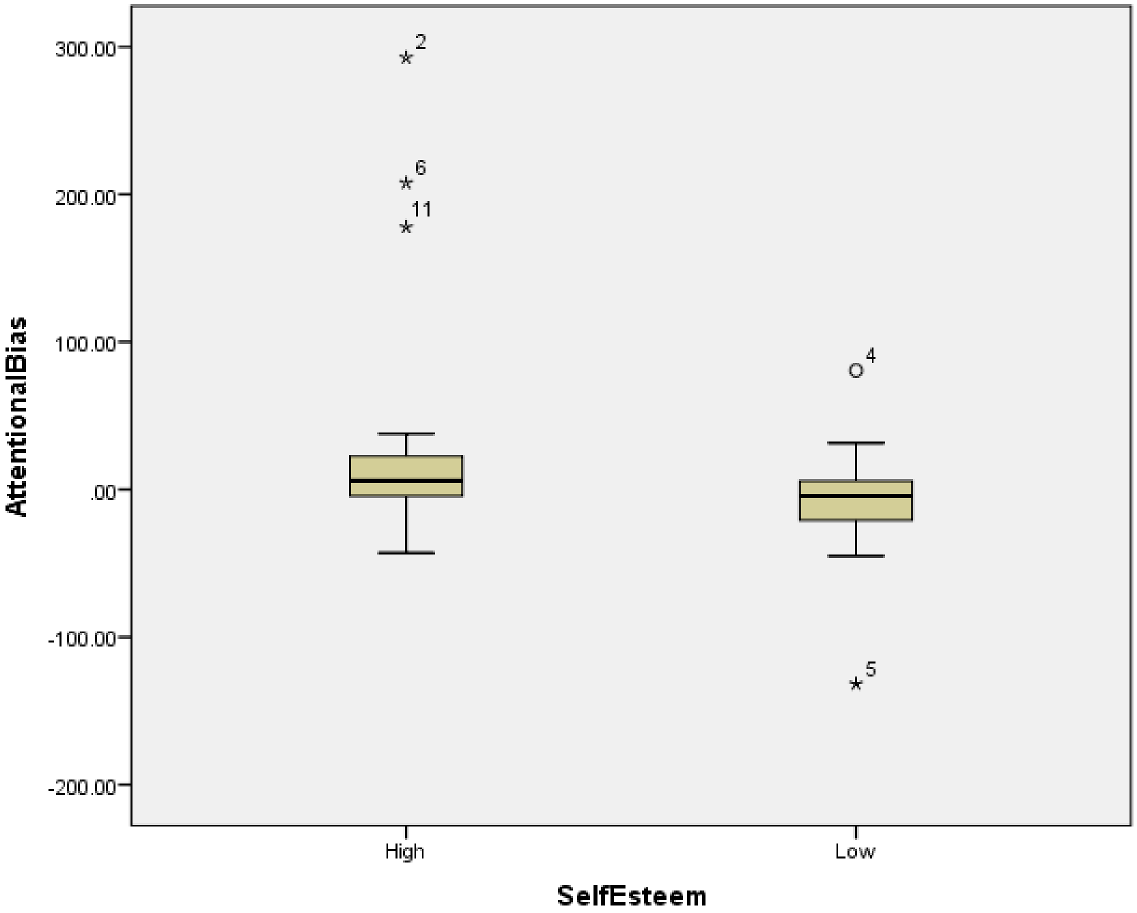


Figure 18: Univatiate general linear model (2 x 2 ANOVA) displaying the effects of dot-probe condition and SE group on attentional bias scores.

Tests of Between-Subjects Effects

Dependent Variable: ABS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Hp2	Noncent. Parameter	Observed Power[b]
Corrected Model	3120.445[a]	3	1040.148	3.372	.030	.240	10.115	.709
Intercept	409.411	1	409.411	1.327	.258	.040	1.327	.201
DPC	1726.909	1	1726.909	5.598	.024	.149	5.598	.631
SEGROUP	61.521	1	61.521	.199	.658	.006	.199	.072
DPC * SEGROUP	1350.321	1	1350.321	4.377	.044	.120	4.377	.528
Error	9871.505	32	308.485					
Total	13186.924	36						
Corrected Total	12991.950	35						

a. R Squared = .240 (Adjusted R Squared = .169)

b. Computed using alpha = .05

Figure 19: A bivariate Pearson's correlation test showing a moderate positive correlation between RSES scores and BDI-II scores

Correlations

		RSES_Score	Depression_Score
RSES_Score	Pearson Correlation	1	-.662**
	Sig. (2-tailed)		.000
	N	40	40
Depression_Score	Pearson Correlation	-.662**	1
	Sig. (2-tailed)	.000	
	N	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 20: Box plot showing the outlying values for participants 7, 16, 22, and 31 in relation to EEG recordings

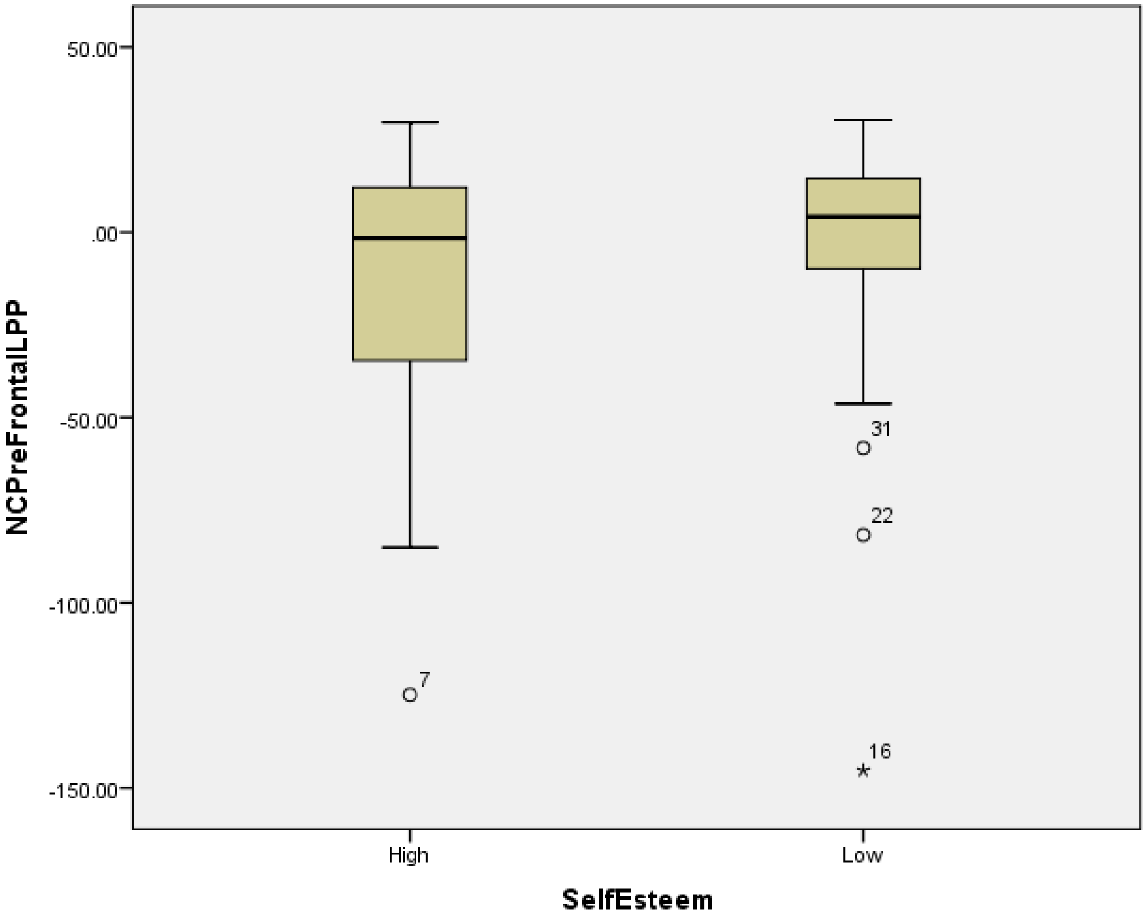


Figure 21: Histogram showing approximate shape of a normal curve for participants in the ABM dot-probe condition, this suggested normal distribution for the group and concurred with the results of the Shapiro-Wilk test.

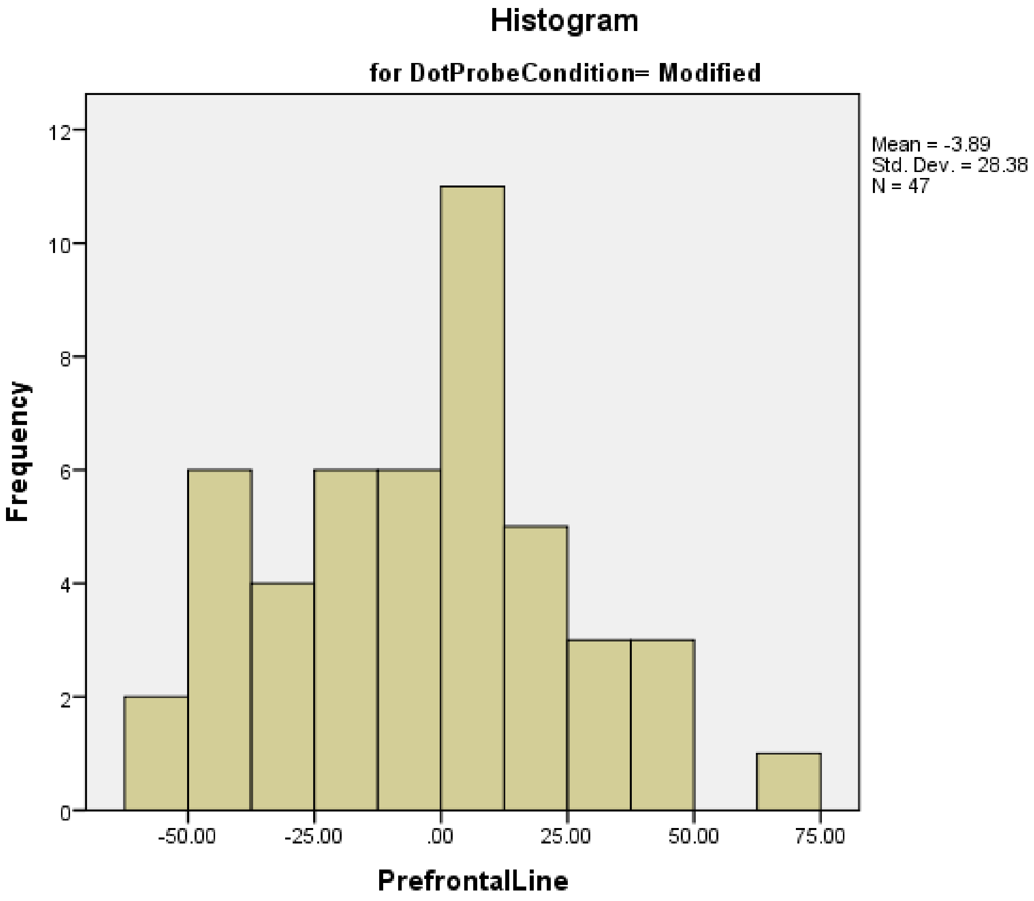


Figure 22: Q-Q plot of EEG amplitudes for participants showing data fell within the estimated line of normality.

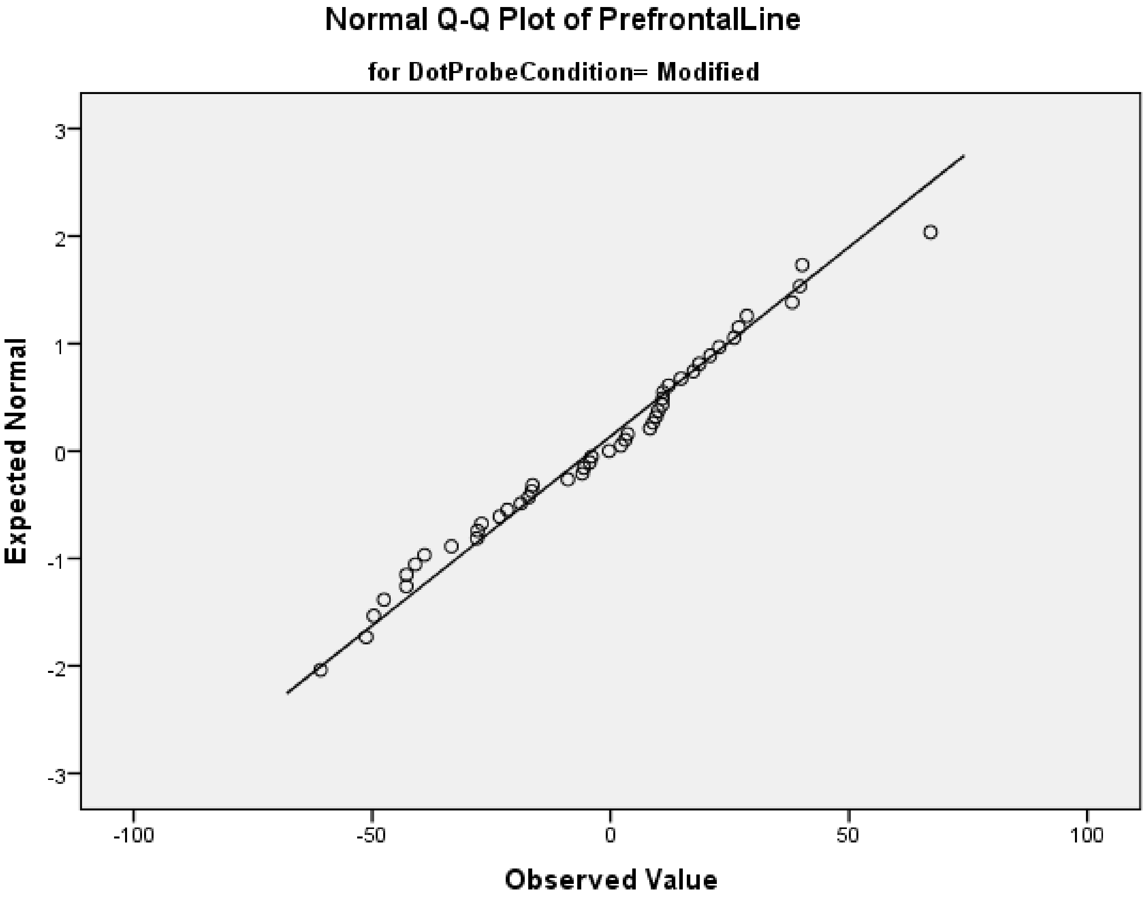


Figure 23: Histogram showing possible deviation of an approximate shape of a normal curve for high SE participants. The data may have been skewed to the right and potentially platykurtic.

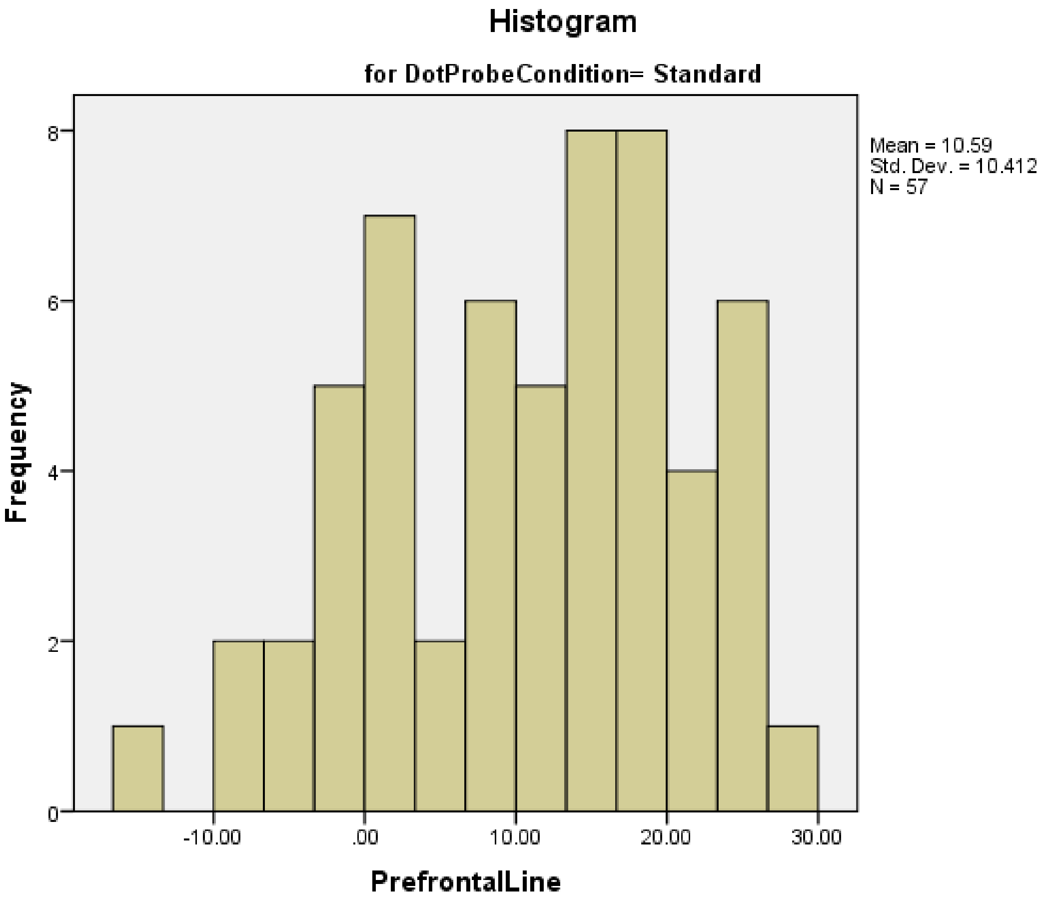
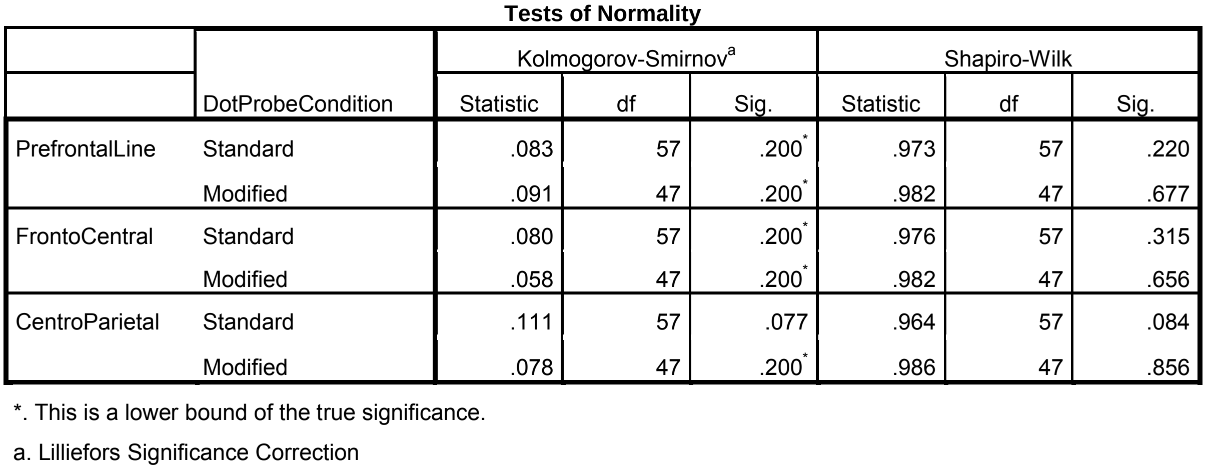


Figure 24: Table showing the P values for the Shapiro-Wilk test of normality regarding the EEG amplitudes for participants in each dot-probe condition at the three regions of interest.



Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	DotProbeCondition	Statistic	df	Sig.	Statistic	df	Sig.
PrefrontalLine	Standard	.083	57	.200*	.973	57	.220
	Modified	.091	47	.200*	.982	47	.677
FrontoCentral	Standard	.080	57	.200*	.976	57	.315
	Modified	.058	47	.200*	.982	47	.656
CentroParietal	Standard	.111	57	.077	.964	57	.084
	Modified	.078	47	.200*	.986	47	.856

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 25: Table showing homogeneity of variance and covariances of the main effect of time was accepted. The F statistic was not positively biased therefore did not renderer it invalid, with a type 1 error occurrence not probable, therefore not violating sphericity.

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Times	.938	1.669	2	.434	.941	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + SelfEsteem + DotProbeCondition + SelfEsteem * DotProbeCondition
Within Subjects Design: Times

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Figure 26: Table showing

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
NCPreFrontalN2	2.299	3	27	.100
NCPreFrontalP3	1.203	3	27	.327
NCPreFrontalLPP	.851	3	27	.478

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + SelfEsteem + DotProbeCondition + SelfEsteem * DotProbeCondition
Within Subjects Design: Times

Figure 27: Table showing

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.846	4.682	2	.096	.867	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + DotProbeCondition + SelfEsteem + DotProbeCondition * SelfEsteem
Within Subjects Design: Time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Figure 28: Table showing

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.833	5.117	2	.077	.857	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + DotProbeCondition + SelfEsteem + DotProbeCondition * SelfEsteem
 Within Subjects Design: Time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Figure 29: Table showing

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
NCFrontoCentralN2	3.263	1	33	.080
NCFrontoCentralP3	5.751	1	33	.022
NCFrontoCentralLPP	7.345	1	33	.011

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + SelfEsteem + DotProbeCondition + SelfEsteem * DotProbeCondition
 Within Subjects Design: Times

Figure 30: In regards to the prefrontal line z line, this table shows the Bonferroni post-hoc test results, a significant difference in amplitude was found between time 1 and time 2 within all participants

Pairwise Comparisons

Measure: MEASURE_1

					95% Confidence Interval for Difference[b]	
(I) Times	(J) Times	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	12.318*	1.804	.000	7.712	16.923
	3	7.397*	1.476	.000	3.630	11.164
2	1	-12.318*	1.804	.000	-16.923	-7.712
	3	-4.920*	1.808	.034	-9.536	-.305
3	1	-7.397*	1.476	.000	-11.164	-3.630
	2	4.920*	1.808	.034	.305	9.536

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Figure 31: Regarding the frontocentral region, this table showing the Bonferroni post-hoc results suggest a significant difference in amplitude was found between time 1 and time 2, time 1 and time 3, but not time 2 and time 3.

Pairwise Comparisons

Measure: MEASURE_1

					95% Confidence Interval for Difference[b]	
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	6.968*	1.504	.000	3.896	10.040
	3	5.113*	1.461	.001	2.129	8.097
2	1	-6.968*	1.504	.000	-10.040	-3.896
	3	-1.855	.973	.066	-3.842	.131
3	1	-5.113*	1.461	.001	-8.097	-2.129
	2	1.855	.973	.066	-.131	3.842

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Figure 32: Regarding the centroparietal z line, this tableshowsthe Bonferroni post-hoc test results, a significant difference in amplitude was found between time 1 and time 2 within all participants.

Pairwise Comparisons

Measure: MEASURE_1

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-2.218*	.498	.000	-3.483	-.954
	3	-1.129	.696	.347	-2.898	.639
2	1	2.218*	.498	.000	.954	3.483
	3	1.089	.556	.180	-.325	2.503
3	1	1.129	.696	.347	-.639	2.898
	2	-1.089	.556	.180	-2.503	.325

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Figure 33:

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
NCCentroParietalN2	.591	1	32	.448
NCCentroParietalP3	.060	1	32	.808
NCCentroParietalLPP	.182	1	32	.672

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.