"WHAT IF…?"

AN EEG-sLORETA STUDY INVESTIGATING EPISODIC FUTURE THINKING IN SUBCLINICAL ANXIETY

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Abstract

The first EEG-sLORETA study to investigate the cognitive and neurophysiological differences between High (Subclinical) Anxiety participants and (Low Anxiety) Controls during Episodic Future Thinking (EFT) tasks. Anxiety disorders are characterised by a negative attentional bias towards future thoughts. Specifically, prospections are perceived as more threatening and personally impactful. Episodic Future Thinking (EFT) is the cognitive process that allows humans to think prospectively about events rich in personally significant and affective detail. Neurocognitive research has posited a neural network (Episodic Core Network) that is recruited during EFT. This study provides the first empirical evidence that regions of the Episodic Core Network are recruited differently between High Anxiety (Subclinical) and Low Anxiety (Control) groups.

A quasi-experimental design was used; GAD-7 and PSWQ scores divided participants into groups. Participants (N = 16; 8 Male, 8 Female) completed a series of EFT tasks while electroencephalographic (EEG) data was obtained (N = 11; 4 Male, 7 Female) using a dense-array 128-sensor EEG net. Two time windows of interest were identified for EEG analyses – approximately correlating to event-related potentials (ERPs) P300 (275-325ms) and the Late Positive Component (LPC; 775-825ms). Mean amplitude at electrode sites of interest during both 50ms time windows was statistically analysed using ANOVA. Source estimation was then completed using sLORETA during both 50ms time windows. sLORETA results at P300 and LPC time windows were analysed using ANOVA.

There was no statistically significant difference in participants' ratings of episodic detail between High Anxiety and Low Anxiety groups for any EFT-Valence condition. The results indicate that High Anxiety participants demostrated significantly higher positive mean potential at Left Temporal and Left Posterior regions; and significantly negative mean potentials at Frontal regions 275-325ms after cue word onset (P300) during EFT tasks. High Anxiety participants demostrated significantly higher mean positive potential at Left Temporal and Left Posterior regions; and significantly negative mean potentials at Frontal, Occipital and Right Posterior regions 775-825ms after cue word onset (LPC) during EFT.

Analyses of sLORETA results at P300 indicate that High Anxiety participants demonstrated significantly higher recruitment of medial prefrontal cortex (mPFC), prefrontal cortex (PFC), and medial temporal lobe (MTL) regions during EFT. Analysis of sLORETA results at LPC indicate that High Anxiety participants demonstrated significantly higher recruitment of PFC, mPFC, lateral temporal and MTL regions during EFT. Analyses of sLORETA results at LPC indicate that High Anxiety participants demonstrated significantly higher recruitment of the insular cortex and middle temporal gyrus (MTG) during negative EFT.

In conclusion, High Anxiety participants generated negative prospections utilising more visuospatial, socioemotional, introspective and schematic information than Controls. This study provides the first set of neurophysiological correlates to anxiety's prospective and anticipatory negative threat-bias and how this relates to EFT.

Author's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institute in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.

Signed …… *Jolian Ardolino* …… Date …….*16/07/2019*……

Contents

LIST OF TABLES

LIST OF FIGURES

1.0. CHAPTER ONE – Introduction

Rationale and Structure of Thesis

1.1. Anxiety disorders are characterised by excessive worry, and an attentional bias towards negative, threatening thoughts about the future (APA, 2013). A longstanding and developed body of research details the cognitive elements that contribute to the pathogenesis and maintenance of anxiety disorders. Episodic future thinking (Szpunar, 2010) is the cognitive faculty that enables humans to prospectively experience hypothetical future scenarios – a form of mental time travel akin to episodic memory (Tulving, 2002). Episodic future thinking is a growing area of research and there are now studies examining the differences between clinical and non-clinical populations with regards to this cognitive faculty. However, these have mainly focussed on clinical neuropsychological areas, including biological and physical damage such as dementias (Irish et al., 2016). Other studies, such as Mercuri et al. (2015) focus on the impact that other factors such as substance misuse may have on EFT.

1.2. The current project makes explicit the implicit links between EFT as a human neurocognitive faculty and anxiety's negative threat-bias. Specifically, the project aims to investigate whether this negative threat-bias has an impact on the process or outcomes of EFT; and if so, determine what this impact may be by applying neurocognitive theory.

1.3. The following chapters are structured to provide a review of the literature together with the methodologies that will be employed and their justification within the project. The results of the project will be presented with a critical discussion of those results in relation to existing theory, future research, and applications.

Prevalence of Anxiety Disorders

1.4. This section will focus on the prevalence and morbidity rates of various anxiety disorders and will make reference to the staggering cost to the UK (and worldwide) economy resulting from anxiety disorders and other common mental disorders. The Global Burden of Disease (GBD) is a term used by the World Health Organisation (WHO) to analyse the economic impact of health issues around the world. All these factors contribute to the importance of further research that can improve and refine current understanding of anxiety disorders, how they develop, and the development of therapeutic interventions and preventative measures. Impact from research focussed on these developments may therefore reduce the Global Burden of Disease arising from Anxiety Disorders and other Common Mental Disorders (CMDs).

1.5. Anxiety disorders are among the most prevalent mental disorders in both UK and worldwide populations, with lifetime estimates ranging from 15-20%, and median age of onset at 11 years (Mohr & Schneider, 2013). WHO (2017) estimate that in 2015, 3.6% of the global population and 4.2% of the UK population had an anxiety disorder. That equates to approximately 264 million people worldwide and 2.56 million people in the UK. This worldwide figure has increased by 14.9% since 2005, which the WHO (2017)

claims is due to population growth and ageing. However, it is important to note that governments and health services around the world have launched campaigns to improve mental health. For example, the UK government launched their "Time to Change" campaign in 2011, funded by the Department of Health; and the Improving Access to Psychological Therapies (IAPT) initiative launched in 2008 and continues to develop (IAPT, 2017).

1.6. Often grouped into the term common mental disorders (CMDs) along with different types of depressive disorders, anxiety disorders cause significant emotional distress and interfere with average daily functioning. Reducing the prevalence of these common mental disorders is a major public health challenge (Davies, 2014). While other major psychiatric disorders such as psychoses arguably have a more significant impact on daily functioning, CMDs have a higher prevalence rate. This results in their cumulative cost to society being significantly higher than other mental disorders (Zivin et al., 2015; McManus, Bebbington, Jenkins, & Brugha, 2016); and even higher when co-morbid with a personality disorder (Rendu et al., 2002).

1.7. The annual cost of mental illness (largely CMDs such as anxiety) in the United Kingdom is approximately £70 billion – 4.5% of GDP (McManus, Bebbington, Jenkins & Brugha, 2016). Furthermore, CMDs are more likely to lead to long term physical, social and occupational disability and premature mortality if left untreated (Zivin et al., 2015), which demonstrates the importance of improving treatment availability and accessibility. Anxiety disorders are some of the most enduring mental disorders and are ranked as the sixth largest contributor to non-fatal health loss globally as "Years Lived with Disability" (YLD) accounting for 24.6 million YLD in 2015 (WHO, 2017). This has multiple ramifications, both for the 264 million people living with anxiety disorders worldwide, but also for the global and UK economy. Mental illness has huge impacts on the UK economy, not just from treatment costs, but also from the loss of work due to the disabling effects of these disorders. For example, mental illness is the leading cause of sick days in the UK, accounting for 70 million sick days in total in 2013 (ONS, 2014); and 41% of people receiving Employment and Support Allowance (ESA) in 2013 did so due to mental or behavioural disorders (OECD, 2014; McManus, Bebbington, Jenkins, & Brugha, 2016).

1.8. Anxiety is seen as a CMD by most, and funding is often directed towards depression, which is the leading cause of disability worldwide (WHO, 2017). However, anxiety is often co-morbid with depression, occurring simultaneously with either being the primary diagnosis (Kessler et al., 2008). This complicates the issue, as they are qualitatively similar in presentation yet distinct from each other in a number of ways (see Chapter Two). Improving understanding of anxiety disorders is paramount to developing treatments and informing policies across the UK and worldwide. It is part of a larger issue, and global organisations have set targets for political change powered by research into mental health – as in the WHO's (2013) Mental Health Action Plan 2013-2020 and the United Nations 2030 Agenda for Sustainable Development (UN, 2016).

Episodic Memory and Episodic Future Thinking

1.9. Tulving (1985) proposed the existence of three distinct but interconnected memory systems: procedural memory, semantic memory and episodic memory. Procedural memory relates to living organisms' ability to learn connections between environmental stimuli and responses – including complex stimuli – and was proposed to be at the bottom of the monohierarchic structure. Semantic memory allows for stimuli-independent models and representations of the world to be constructed and retained. Episodic memory (EM) is described by Tulving (2002) as a neurocognitive function humans possess that enables them to experientially remember past *experiences*. Tulving (2002) argues that episodic memories may be as important in our development and functioning as the experiences we perceive in the physical world. Most importantly, this human faculty of mental time travel is not simply a passive "matter-of-fact" reconstruction of events from an external perspective, but rather a *re-experiencing*. The individual who remembers is able to access the phenomenological aspects of the event, rather than being limited to external descriptions of the environment, for example. Therefore, the episodic memory accesses the affective components of the event and becomes an emotional stimulus for the individual who is remembering.

1.10. Episodic Future Thinking (EFT) is therefore the cognitive faculty of prospectively experiencing a future event or situation. The level of detail is personal, relates to the individual's perspective and phenomenology of the imagined event, and is not constrained to external details (such as environmental description) from an observer perspective (similar to episodic memory). This makes EFT unique, in that it demonstrates the human ability to mentally rehearse and *pre-experience* hypothetical events, to prepare for multiple eventualities. The affective component of EFT is important to consider, as humans experience emotions mentally and physically related to the prospective event prior to physically experiencing it in current objective reality (Lang, 1979; Moscovitch, Chiupka & Gavric, 2013; Ji, Heyes, MacLeod & Holmes, 2016; Bullock, Newman-Taylor & Stopa, 2016; Skodzik, Leopold & Ehring, 2017). Damasio's (1999) Somatic Marker Hypothesis posits that emotional events are marked by bodily sensations and emotion; and that subsequent impending recurrence of similar events results in similar anticipatory somatic markers. As discussed by Tulving (2002), mental reality may be as important to humans as physical reality. Therefore, anxiety responses to an imagined phobic stimulus such as flying, may lead one to continue avoiding flying abroad. The result is the reinforcement of the feared stimulus, continuing the cycle of fear and maintaining that anxiety. Similarly, positive mental imagery and visualization techniques in sports have been investigated with positive results within a variety of populations (Stanković et al., 2011; Catenacci et al., 2016; Slimani et al., 2016). This can be seen as an adaptive function, and a useful neurocognitive faculty from evolutionary, professional and everyday perspectives. It can also be utilised within therapeutic contexts, such as Imaginal Exposure Therapy (Wells & Matthews, 1994; 2014). This meta-cognitive perspective on episodic future thinking is important to consider, as it is relevant to the meta-worry that is characteristic to anxiety disorders such as GAD (Hirsc & Matthews, 2012).

1.11. In summary, episodic memory and episodic future thinking (EFT) refer to the human mental faculty to *re-experience* and *pre-experience* events. They can be seen as two ends of the same spectrum and share a large proportion of neural processing networks (Schacter, Benoit, De Brigard & Szpunar, 2015), and these will be discussed in Chapter Two. The atemporal version of EFT and EM is scene construction, and all three of these mental faculties (EFT, EM and Scene Construction) share common functional neural networks (Irish et al., 2015). Episodic counterfactual thinking (Schacter, Benoit, De Brigard & Szpunar, 2015) is also investigated as a meta-cognitive faculty to imagine an episodic event (memory or prospection) in an alternative way – e.g. imagining what could have happened if you said "X" instead of "Y" in a previous situation.

Conceptual Overlap with Mental Imagery, Creativity and Dreaming

1.12. While EFT is a discrete cognitive faculty that humans possess, it is also conceptually similar to other areas of research, such as mental imagery and creativity. Lang's (1979) Bio-informational Theory of Emotional Imagery, posited the affective and physiological reactions that mental imagery can cause. Furthermore, these reactions have been investigated for their potential use in therapy for a range of mental disorders (Foa, Hembree, & Rothbaum, 2007; Holmes & Mathews, 2010; Ji, Heyes, MacLeod, & Holmes, 2016). Emotional imagery is qualitatively similar to EFT in its role of planning, problem solving and self-regulation through emulation of possible events and their repercussions (Moulton & Kosslyn, 2009; Ji, Heyes, MacLeod, & Holmes, 2016). Important to consider are the subtle distinctions made by Tulving (2002) in his conceptualisation of episodic memory. One of which is relevant here. Episodic memories are specific to when, where and how the event happened; including what the somatic markers of the event may be (Damasio, 1999); and therefore, require that this event has happened in the *individual's* past. This distinction becomes blurred in the realms of episodic future thinking because the imagined event has not yet happened, while mental imagery allows for the construction of imagined events in the present. For example, numerous studies have used present-tense verbal cues to elicit emotional mental imagery (Holmes & Mathews, 2005; Ji, Heyes, MacLeod, & Holmes, 2016). Studies into EFT have – quite logically - repeatedly used affective cues that instruct the participant to think of a future event, and often sets temporal distance of the target event (e.g. 5 years). It is arguable that EFT is a component of emotional mental imagery, in the same way that episodic memory is a component of the overarching memory system. The concepts are similar in their neurobiological correlates, as regions activated during emotional mental imagery are also present in the Episodic Core Network (see Table. 1 below). Neuroimaging studies have found activation of the amygdala, nucleus accumbens, medial prefrontal cortex (mPFC) and anterior cingulate cortex (ACC; Damasio et al., 2000; Kim et al., 2007; Sharot, Riccardi, Raio, & Phelps, 2007; Costa et al., 2010).

1.13. Creativity is conceptually similar to EFT, in so far as a creative individual must be able to vividly construct visual, spatial, musical, and semantic information into a new "creation" or concept. In this regard, the Constructive Episodic Simulation Hypothesis (Schacter & Addis, 2007) maps very nicely onto the processes involved in creativity and one could reasonably assume that similar neurobiological correlates would be found.

However, the neurological research into creativity is stagnated, uncoordinated and disparate in nature. A recent meta-analysis of creativity research by Dietrich & Kanso (2010) found numerous issues, including with the experimental definitions of creativity that have not developed significantly since Guilford's (1950) divergent thinking. Broadly speaking, divergent thinking – thinking of alternative and novel uses for specific objects - has been utilised as a proxy concept for creativity, which is problematic despite its easy measurement. Dietrich & Kanso (2010) investigated 63 articles and 72 studies into divergent thinking, artistic creativity (visual and musical) and insight (so-called "a-ha moments") and found no clear reliability for neurobiological findings other than creative tasks involved changes in prefrontal activation. They argue that creativity is too broad a concept to be studied holistically and instead must be broken into its component faculties – much like memory has been.

1.14. Neurophysiological correlates of dreaming, creativity and emotional mental imagery are similar (Bassetti, Bischof, & Valko, 2005; Jung, Flores & Hunter, 2016; Kim et al., 2007; Sharot, Riccardi, Raio, & Phelps, 2007; Costa et al., 2010), generally all functions heavily recruit prefrontal, and medial temporo-occipital regions. However, dreaming is discrete in that attention-focusing areas of the brain are hypoactive during REM sleep and correspond with low levels of perceived control over the dreamed events. The purpose of these neurocognitive faculties is also significantly similar – to consolidate affective information and process emotional events in order to perform better in similar future circumstances. Maladaptive emotional imagery, prospective thoughts and dream disturbances have all been linked to a range of emotional psychopathology, including GAD (Mullin et al., 2017). For the purpose of this project, however, particular interest is paid to the role of maladaptive functioning within these faculties for anxiety disorders. Studies into anxiety disorders have shown that cognitions about the future are distorted, and events are seen as more threatening and emotionally impactful than asymptomatic perception of future events. This is reflected in the diagnostic description of anxiety disorders within DSM-V (APA, 2013) and the ICD-10 (WHO, 2010). Furthermore, it is the inability to sufficiently control the perceived and anticipated emotional impact that characterises a range of anxiety disorders (APA, 2013). This specific trait has been utilised within CBT in clinical practice, as emotional imagery of threatening prospective events is elicited and subsequently challenged throughout the therapeutic process (Holmes & Mathews, 2010; Ji, Heyes, MacLeod, & Holmes, 2016). This demands that the patient redirect their attention and engage in counterfactual thinking to actively challenge their initial imagined episodes and memories. This is important to consider, as current neurophysiological studies are focussing on whether neurobiological correlates of anxiety processing (for example, see Strawn et al., 2012) are predictive of treatment outcome (Hahn et al., 2016; Burkhouse et al., 2017) and to personalise therapeutic approaches offered to patients (Lueken et al., 2016). Interestingly, areas associated with emotional attention, such as the dorsolateral prefrontal cortex (DLPFC; which are hypoactive during REM sleep) appear to be predictive of treatment outcomes (Burkhouse et al., 2017). While further research is required to validate these claims (perhaps from a meta-analytic review) the initial findings are promising and provide further evidence to support the aim of the current project: to investigate potential

statistically significant neurophysiological differences between high anxiety participants and controls during episodic future thinking.

Neurobiological Differences in Anxiety

1.15. A large and growing body of research exists that utilises EEG and functional magnetic resonance imaging (fMRI) to examine the relationships between cognition in anxiety disorders, and neuropsychological function and structure. For example, neurobiological correlates of fear have been investigated to form a “cognitive-neurobiological-information-processing model” (Hofmann, Ellard, & Siegle, 2012). Within this model, individuals with anxiety present with an early activation of subcortical networks such as the amygdala, hippocampus, and insular cortex that are involved in threat perception. This suggests that individuals with anxiety are “hypervigilant" in their neurological processing of perceived threats and therefore activate these areas significantly quicker than ‘controls’, prior to the subsequent activation of cortical areas involved in avoidant responses (such as the anterior cingulate cortex and prefrontal cortex).

1.16. The above model was developed using explicitly clear affective stimuli; however, anxiety and anxious responses often involve an element of uncertainty. Zaretsky, Mendelsohn, Mintz, & Hendler (2010) suggest that uncertainty of emotional stimuli recruits a specific network involving the amygdala, dorsomedial prefrontal cortex (dmPFC), and dorsolateral prefrontal cortex (dlPFC). This has implications for real world situations, as it suggests that threat responses can recruit higher order regions of the brain when the threat posed is uncertain - also known as the “relevance detector theory” (Zaretsky, Mintz, & Hendler, 2010).

1.17. These findings suggest that the amygdala is involved in subjective interpretation of threat. The amygdala and its subcortical network may respond to potential environmental, physical and social threats in a hypervigilant manner in individuals with anxiety disorders. Individuals with anxiety disorders are more readily processing potential threats on a daily basis, which results in increased sensitivity to anxious affective stimuli (or uncertain stimuli) and more frequent avoidant responses. Wheelock et al. (2014) suggest that unpredictable threats can elicit larger affective responses and that the dorsomedial prefrontal cortex (dmPFC) serves as a “neural hub” that influences areas such as the amygdala when threats are unpredictable, while the same process is seen in the dorsolateral prefrontal cortex (dlPFC) when threats are predictable. Therefore, the dmPFC-amygdala network may activate more frequently (and at an earlier stage) in individuals with higher levels of anxiety than others with low anxiety.

1.18. Neurobiological correlates of anxiety disorders have recently come under scrutiny for their predictive ability in treatment outcome, and personalised therapeutic approach (Hahn et al., 2015). Furthermore, studies are now tracking the neurophysiological changes that occur as a result of evidence-based interventions like CBT for a variety of psychopathology (Yang, Kircher & Straube, 2014; Hahn et al. 2015; Mason et al., 2016; Mason, Peters & Kumali, 2016; Burkhouse et al., 2017). General changes tend to be localised to the dmPFC, dlPFC and anterior cingulate cortex (ACC) – all areas that are linked with affective attentional processing. Taken with the above information regarding the neurobiological correlates of mental imagery, EFT and dreaming, it is reasonable to

suggest that by repeatedly evoking and actively challenging threatening future thoughts, patients with anxiety are actively changing their neurophysiology to more closely resemble healthy and adaptive activity within these areas. This also predicts better remission rates in adults who receive treatment for anxiety (Hahn et al. 2015), suggesting that the brains neuroplasticity is playing a role and affective attentional processing is becoming more refined – translating at a cognitive level into fewer catastrophic misinterpretations and less threatening prospective perceptions.

1.19. In summary, the above findings have implications for the current project. During experimental tasks, participants are to be presented with (predictable) affective stimuli. Therefore, it is possible that results may demonstrate similar recruitment of the amygdala-dmPFC network in participants with high levels of anxiety. The current project is specifically concerned with potential differences in the recruitment of the episodic core network (which includes the medial prefrontal cortex and other prefrontal regions) between High Anxiety and Control groups. Any potential differences between groups in these neural regions will be tentatively discussed in relation to the above points on hypervigilance to threat and threat (un)certainty (see Chapter FIVE below).

Neurocognitive Approaches and Explanatory Models

1.20. If one combines the models of cognitive theory of anxiety and the neurobiological findings from functional neuroimaging studies, a pattern of hyper vigilant threat perception quickly emerges at both levels. This relationship between cognitive theory and neuroscience is commonly referred to as a neurobiological correlate. The successful combination of both neuroscientific and cognitive theory will be referred to as neurocognitive theory for the purpose of this project. Neurocognitive theory proposes that all cognition has an underlying neurobiological correlate of networks and neural activity, both at the structural and functional level. These networks of neural activity are measurable and accessible with the use of increasingly complex technology, including fMRI, EEG, MEG and PET.

1.21. Singer, Eapen, Grillon, Ungerleider, & Hendler (2012) suggest that there is abundant evidence that anxiety has an effect on allocating cognitive resources to processing threats, but little clear research and empirical evidence as to the initial selection procedure that identifies a threat in anxious individuals. Multiple cognitive models of anxiety disorders have stated that high vigilance to threat suggests an underlying mechanism that exists in pre-awareness. Most theories have also posited that this process involves relatively low-level neurological processing within the subcortical regions (Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Öhman, 1993; Öhman & Wiens, 2004; Williams, Watts, MacLeod, & Mathews, 1988; Singer, Eapen, Grillon, Ungerleider & Hendler, 2012). When combined with Hofmann, Ellard & Siegle's (2012) cognitive-neurobiological-information-processing model of hypervigilant neurological processing in specific areas, a neurocognitive explanation can be formed. The cognitive resources are allocated to processing threats in a hypervigilant manner, and this is reflected in neurological activity, patterns of thinking, physiological reactions and behavioural responses. Below is a simple example of this complex, cyclical and iterative

process. For the purposes of application, this explanation will be applied to a phobia of wasps – otherwise known as spheksophobia.

1.22. The stimulus in this example could be a buzzing sound heard from nearby. This alone would pass through auditory processing and link closely with neurological activity in areas (discussed above) related to processing threats. This threat could be uncertain, as the individual has only heard the buzz and not seen the wasp yet, so it could be emanating from other sources. Therefore, areas such as the amygdala and dmPFC would be involved to process the uncertain threat accordingly. As this neurological processing approaches conscious awareness, the individual experiences thoughts and physiological sensations related to *threat*. This could include a catastrophic misinterpretation (Clark, 1986) such as "it's a wasp, it's after me" along with physiological reactions such as those experienced in the "fight-flight-freeze" response (Gray, 1978; Blanchard et al., 2001.). The interaction of these factors leads to a surge of adrenaline, spurred on by thoughts of impending threat and the brain co-ordinating the body to be vigilant and attentive. The combination may lead to the individual running away, without seeing the wasp or confirming the source of the buzzing noise. Now the individual has fled the source of the auditory stimulus accordingly, they have effectively survived what the body and mind interpreted as a "threatening situation" and this has repercussions. This successful result (no physical damage and survival) could lead to *reinforcing* all factors that contributed to this phobic reaction in the individual. When combined with long-term potentiation, the networks that are repeatedly activated simultaneously are strengthened – particularly their connections with the hippocampus (Bliss, 1993; Akhondzadeh, 1999). Therefore, the result (e.g. avoidant behaviour) can impact the process (e.g. phobic response) equally as much as the process impacts the result.

1.23. In summary, the project will focus on investigating neurophysiological (EEG) and cognitive (self-report) data involving the Episodic Core Network (Schacter, Benoit, De Brigard & Szpunar, 2015). The aim of the project is to establish the possible neurocognitive differences in episodic future thinking (EFT) between participants with high levels of trait anxiety and asymptomatic controls. Chapter ONE has outlined the importance of research into anxiety disorders and briefly conceptualised episodic memory and EFT. The theoretical and practical considerations required to design a comprehensively informed and effective study are outlined in greater detail below. Chapter TWO will focus on the theoretical developments, specific measures and issues of definition that exist within the empirical literature surrounding these topics. These considerations are then used to inform the rigorous design of the project, presented in Chapter THREE.

2.0. CHAPTER TWO – Literature Review

Anxiety Disorders

Definitions

2.1 Broadly speaking, anxiety disorders all share common features of excessive fear and anxiety, along with avoidant behaviours, often accompanied by a level of social withdrawal. While fear and anxiety overlap as concepts, it is important to note the distinction between the two as stated by the American Psychiatric Association (APA, 2013). Fear is the emotional response to a real or perceived threat and anxiety is the anticipation of future threat. Anxiety is the heightened level of vigilance to future or imminent threats, which also involves physiological reactions and thought processes. Together, these two features can become maladaptive, causing disturbances in the individual's ability to function "normally" in everyday life. At this point, these natural responses to perceived threats and danger are considered at the level of a diagnosable mental disorder. This section will discuss the range of anxiety disorders and the issues with their classification in the clinical literature. This is important because the fine but definitive lines drawn between distinct sub-types of anxiety disorders also reflects the possible fine line between subclinical and clinical levels of trait anxiety. Within the present study, the use of subclinical anxiety as a quasi-experimental condition to compare with asymptomatic controls is pertinent to the discussion below.

2.2 Anxiety disorders can vary in their specific presentation and pathology, and therefore discrete categories have been formed within the diagnostic manuals available to clinicians. However, the main anxiety disorder focussed on within the current project is Generalized Anxiety Disorder, otherwise known as GAD (APA, 2013). GAD is characterised by the overgeneralisation of anxiety and fear in everyday life, which negatively impacts on an individuals' ability to function. The clinical psychometric measure commonly used to monitor GAD symptomology is the GAD-7 (Spitzer, Kroenke, Williams & Lowe, 2006), which measures common features of GAD (diagnostic category) and trait anxiety (dimension upon which the general population fluctuates).

Issues in Diagnosis

2.3 Anxiety disorders are amongst the most common mental disorders, otherwise known as CMDs (WHO, 2010). Prevalence rates in adults range from 0.9% in America, and between 0.4% and 3.6% in other countries (DSM-V; APA, 2013). Despite being so common and widespread across the UK and worldwide, there remains dispute over their diagnoses. Their definition and diagnostic criteria have changed and developed over time, from a broader concept of anxiety as seen in Beck et al. (1991) earlier cognitive (behavioural) therapy work, into distinct subtypes of anxiety disorders reflected in diagnoses today. Clinical psychologists, psychiatrists, and other health professionals rely on guidance from a limited number of diagnostic tools which share certain features but differ in their underlying philosophy. For example, one such tool that provides guidance specifically for mental health clinicians in training is the Diagnostic and Statistical

Manual, which is currently on its fifth edition (DSM-V; American Psychiatric Association, 2013).

2.4 The DSM-V and its predecessors have been cause for great debate over the last few decades amongst the medical and academic community. This is mainly down to the underlying philosophy and science behind the categories of various mental disorders, of which anxiety is but one. Common medical approaches to disease and disorders include a strictly scientific diagnostic test based on biology. A classic illustrative example would be a simple blood test. However, mental disorders do not so easily lend themselves to this level of diagnostic scrutiny (although neuroscience aims to tackle this issue in the future). With that being said, there must be a basis for these diagnoses and indeed, the existence of these (increasingly discrete) categories of mental disorders. The best way to describe diagnostic terms used in the DSM-V is as operational definitions (Harkness, Reynolds, & Lilienfield, 2014). In the DSM-III (APA, 1980), the statement from the American Psychiatric Association was that diagnoses were atheoretical in regard to the etiology of disorders (except for disorders where this was well established). Therefore, the operational definitions utilised to form the DSM-V and all of its predecessors arose from professional therapeutic practice with patients, in a variety of psychotherapeutic contexts, across a variety of social and geographical contexts. Consensus on an empirical basis was the foundation of these definitions, and therefore it was vital to establish an evidence-base for these categories. Teams of professionals have heavily researched anxiety disorders in the DSM (research team), with the latest edition (DSM-V) comprising over 12 years of research. There are, however, implications for individuals with high levels of trait anxiety just below the clinical threshold. Within this study, these individuals are referred to as subclinical, and form the quasi-experimental group (independent variable) for comparison with asymptomatic controls.

2.5 Throughout the years, the number of discrete anxiety disorders has risen steadily along with increases in research and the resulting changes in conceptualisation of disorders from Freud's early theories of anxious neuroticism (Frances et al., 1993). The point remains however, that diagnosis based on agreement between clinicians does not constitute a naturally occurring disorder that can be scientifically analysed using the basis of biology or physiology – these operational definitions serve as proxy diagnoses. Famously, and most controversially, homosexuality was categorised as a diagnosable mental disorder in various degrees of explicitness in DSM-II (APA, 1968), DSM-III (APA, 1980) and DSM-IV (APA, 1994) until it was removed entirely in DSM-V (APA, 2013).

2.6 The above examples demonstrate how any diagnostic definitions present in the DSM-V must be critically interpreted. On the other hand, an individual experiencing the symptoms of an anxiety disorder at a diagnosable level (meeting clinical thresholds) will be unlikely to gain access to therapeutic interventions that could help them without a diagnosis. Therefore, if one removes the clinical label entirely, the individual would be left suffering but have no access to support from clinical professionals. For this purpose, these operational definitions are given power to open access for members of the public to receive help. The above contention has sparked proposals from opponents of the current system of diagnoses for a review of systems (ROS) approach to address this "crisis in clinical description" (Harkness, Reynolds, & Lilienfield, 2013). However, for the

purposes of this thesis, the existing empirical framework stemming from DSM-V and ICD-10 (soon ICD-11) and clinical psychological research will be utilised.

2.7 Within this project, the terms “anxiety” and “anxiety disorder” are used carefully. For example, the participants within the experimental group are labelled as “subclinical” because they score highly on clinical psychometric measures of anxiety (see Chapter THREE) but they have no official diagnosis. In this way, individuals with a diagnosis are safeguarded against participating in a study on worry that could cause them distress in some way. However, within the critical discussion at the end of this thesis, consideration is given to the fine lines between individuals with and without a diagnosis, and how this could be applied to wider contexts. For example, Zimmerman, Chelminski & Young (2004) examined the impact of clinical significance as a factor in psychiatric outpatients and found that it only decreased the diagnostic rates by approximately 2% – but what of the general population? An individual’s trait anxiety level may still impact their life in a variety of ways, but not meet clinical threshold for diagnosis. Is this predictive of future diagnoses (as in Wolitzky-Taylor et al., 2014) or simply reflective of the variance within society?

2.8 Diagnostic definitions for Anxiety Disorders differ slightly between the Diagnostic and Statistical Manual – five (DSM-V; APA, 2013) and the International Classification of Diseases – tenth revision (ICD-10; WHO, 2016), however, they share similar traits. The main development from DSM-IV-TR (APA, 2000) to DSM-V (APA, 2013) is the subtle lifetime developmental perspective to classifications. For example, the DSM-V lists anxiety disorders in chronological order by median age of onset – starting with Separation Anxiety Disorder and concluding with Panic Disorder (Mohr & Schneider, 2013). Comparatively, the ICD-10 (WHO, 2016) – which is used throughout Europe and the United Kingdom – is grounded in the assumption of discontinuity between adult and childhood anxiety disorders. This has been critiqued for its contrary position to empirical research, which suggests a developmental perspective, and a clinical psychology of the lifespan is most appropriate (Mohr & Schneider, 2013). Furthermore, the DSM-IV diagnoses more children with anxiety disorders than ICD-10, but not the same children – indicating poor compatibility between the two instruments (Adornetto et al., 2012). While the ICD-11 is currently under construction, it appears that Anxiety Disorders that occur across the lifespan are being grouped together, with a focus on distinguishing disorders based on apprehension (Kogan et al., 2016). The ICD-11 is expected for release in 2018, and some members of the DSM-V research team are working with and advising the ICD-11 working group on the classification of mood and anxiety disorders. Hopefully this will lead to increased compatibility between the two instruments, and further clinical utility across a wide range of geographical and cultural contexts – which appears to be the WHO’s aim (Kogan et al., 2016).

2.9 At present however, the ICD-10 focusses on the presenting (often physiological) symptoms and gives examples of some corresponding worrisome thoughts but does not go on to describe the pathology of this disorder or its early signs and onset. The DSM-V elaborates within a developmental perspective to create a more reasonably balanced view of the disorder and its development. This lends itself to case formulation approaches used in clinical psychology, whereby the professional works collaboratively

with the patient to discuss relevant life factors and personal history, developing an idiosyncratic narrative of events leading to diagnosis (Johnstone, & Dallos, 2014; Flinn, Braham, & Nair, 2015; Wells, 2016; Ingram, 2016). This approach differs to traditional diagnoses that could be made from the ICD-10 guidance, which does not include background information, instead placing emphasis on symptomology. If the focus is on symptomology, then clinicians (such as GPs or Psychiatrists) may aim to prescribe a series of psychopharmacological medications to treat the presenting issues (Linden et al., 2013). The difference is implicit at the level of description, and explicit in the approach to diagnosis and treatment.

What is Subclinical Anxiety?

2.10 Subclinical refers to a level of trait anxiety that is above "normal" or "optimal" (asymptomatic) ranges, but below clinical significance for diagnosis of an anxiety disorder. Issues arise when posing the question – if trait anxiety fluctuates on a spectrum, what is normal for the general population and what constitutes a clinical mental disorder? Robles et al. (2015) found that 60.4% of mental health professionals specified that one or more diagnoses should be removed from current categories contained in both the DSM-V (APA, 2013) and ICD-10 (WHO, 2016). The most commonly cited reason for removal of mental disorders was that these diagnoses represent problematic boundaries between normal and psychopathological conditions. Additionally, the fine line between disordered and acceptable functioning in these areas appeared to lead to stigmatisation of certain individuals, which was cited as the reason for removal 24.1% of the time. It is important to note that anxiety disorders were not included in categories that should be removed in this study (other than mixed anxiety and depressive disorder). However, it does indicate the fluidity of diagnostic categories as operational definitions under which professionals operate; and the potential issue of pathologizing normal human behaviour.

2.11 The construct validity of the subclinical anxiety category is a recent development and has mainly been investigated for its predictive potential as a risk factor contributing to later development of anxiety disorders across multi-ethnic populations (Hishinuma et al., 2001). However, recent work has seen promising results in treating subclinical populations with transdiagnostic preventative interventions (Korte, 2016). Furthermore, Laeger et al. (2012) found that subclinical anxiety was significantly positively correlated with increased amygdala-dlPFC coupling during negative word processing (using fMRI measures). This suggests that elevated levels of trait anxiety (prior to/without diagnosis) are associated with functional differences for affective processing, similar to what would be expected from a clinical sample. Therefore, it appears that subclinical anxiety is a valid discrete group within the continuum of trait anxiety (asymptomatic to disordered) that can be studied within quasi-experimental research. Furthermore, preventative measures can be developed and targeted to this group to decrease the number who later develop anxiety disorders, such as GAD. Within the present project, subclinical anxiety is used as a group within a quasi-experimental design. To the best of the researcher's knowledge, there has been no other study that investigates potential differences in EFT between asymptomatic and subclinical groups.

Towards a Developmental Bio-Psycho-Social Explanatory Model

2.12 Beck's (1979) Cognitive Model of Emotional Distress is one of the most commonly referenced formative explanatory models of anxiety (and other affective) disorders. It has been extensively and empirically tested and found to be useful in the success of cognitive therapy for a variety of anxiety disorders including generalized anxiety disorder (GAD) and social anxiety disorder (SAD). Beck's cognitive model posits that negative automatic thoughts (NATs) lead to symptoms - behaviours, physical responses, other thoughts and feelings – which then interact with each other to create a perpetuating cycle. Well's (2005) 'vicious circle' cognitive model of panic posits that internal/external triggers cause an individual to perceive a threat, leading to the cycle of anxiety, physical/cognitive symptoms and misinterpretations. Anxiety disorders are heavily characterised by future-oriented NATs in the form of anticipatory questions such as 'what if…?' (Clark and Steer, 1996) and catastrophic misinterpretations (Clark, 1986). The cognitive model of anxiety is useful in its approach to explaining anxiety disorders because it has been systematically developed and revised alongside application in cognitive therapy – as Beck was a huge advocate that no theory of mental disorder can be developed without being derived from practical applications (Clark and Steer, 1996). This is a strength that previous (mostly Freudian psychodynamic) explanations do not have as they were primarily inductive, not deductive. The cognitive models of anxiety are so closely related to their application in cognitive therapy that they are constantly updated in accordance with what works in practice. The above early explanatory models have since been developed using statistical analyses to explain discrete diagnoses – such as GAD. For example, the Cognitive-Behavioural Model of GAD (Dugas, Gagnon & Ladouceur, 1998; Dugas, Marchand & Ladouceur, 2005) posits that GAD is defined by its intolerance of uncertainty. This factor separates it from other anxiety disorders, such as Panic Disorder with Agoraphobia, for example (Dugas, Marchand & Ladouceur, 2005). Therefore, questions can be asked of the relationship between this intolerance of uncertainty and episodic future thinking. "What if…?" questions are undoubtedly starting points from which prospection (EFT) can begin; and prospection is inherently uncertain.

2.13 Cognitive behavioural models can be applied to clinical practice in cognitive behavioural therapy (CBT) for GAD. Results from CBT demonstrate the potential to restructure cognitions, a contrasting view to reductionist and deterministic biophysical explanations and psychopharmacological treatments. It is noted however, that there is an interaction between the cognitive and biological explanations of disorders that has been focussed on more recently within the discipline, using functional magnetic resonance imaging (fMRI) technology in order to establish functional neurophysiological correlates (patterns of neural activity) related to 'faulty cognitions' of threat and fear (Hofmann, Ellard and Siegle, 2012). By incorporating social explanations at micro and macro levels, relating to negative life-experiences such as social deprivation and trauma or abuse (Guze, 1989), one can begin to more accurately formulate the pathogenesis and maintenance of anxiety disorders. Other social explanations include parenting style and specific related factors such as maternal and paternal control, authoritarian

parenting styles and overprotection or rejection behaviours (Young et al., 2013; Erozkan, 2012; Creveling, Varela, Weems, and Corey, 2010). One may even go so far as to call "stigma" a significant predictive factor in the pathogenesis and maintenance of anxiety disorders from a social level of explanation. A recent study by McLaughlin and Hatzenbeuhler (2009) summarises anxiety sensitivity as a meta-cognitive fear of anxiety symptoms – including physical sensations of panic such as sweating or increased heart rate – resulting from beliefs that these are socially, physically or psychologically harmful or unacceptable. This idea that symptoms of anxiety are socially harmful and unacceptable could be strongly linked to social stigma surrounding anxiety disorders (and mental health problems in general). That this could predict the development of an anxiety disorder better than trait anxiety itself (McLaughlin and Hatzenbeuhler, 2009) empirically supports the contributory effect of perceived social stigma to mental (anxiety) disorders.

2.14 Behavioural explanations for anxiety disorders are particularly useful when applied to treating phobias. For example, behaviourism takes the theories of classical and operant conditioning, along with social learning theory and explains phobias as learnt irrational fears of stimuli – as demonstrated in the classic "Little Albert" study (Watson and Rayner, 1920). This theory also relates to the vicious circle of avoidance (Williams et al., 2002), which highlights that anxiety results in avoidance of feared stimuli and therefore reduced belief in the individual's ability to cope with it, and life in general (self-efficacy) – a form of conditioning. These explanations often result in useful therapeutic applications, such as systematic desensitisation – a progressive reconditioning therapy whereby the patient is presented with a hierarchy of phobic stimuli getting closer to the most phobic stimulus while actively relaxing themselves with techniques such as guided and focussed breathing (Bennett, 2011). For example, a patient with arachnophobia may be presented with images of spiders, followed by video, and progressively increase the exposure until perhaps even holding a spider is tolerable with use of relaxation techniques. Systematic desensitisation has also been found to be significantly effective when used concurrently with cognitive behavioural therapy (CBT) (Triscari et al., 2011), demonstrating the integrative possibilities of cognitive and behavioural explanatory models and applications for anxiety disorders.

2.15 The current biopsychosocial model within psychology suggests an interaction between biological, psychological and social factors in the pathogenesis and maintenance of anxiety disorders. However, this has seen calls for a restructuring by researchers who suggest that psychological processes mediate the effects of other factors on developing anxiety (and other mental) disorders (Kinderman, 2013). Kinderman's (2005) psychological model of mental disorder posits that biological, social and circumstantial factors all interact to impact on the disruption or disturbance of psychological processes resulting in mental disorders. Kinderman's (2013) study found a significant mediatory effect of psychological processes such as rumination and self-blame on strongly predictive factors such as family history of mental health difficulties, social deprivation and traumatic life-experiences in levels of anxiety (and depression). However, other support for this model can be found in cognitive based research on looming vulnerability, which has been shown to correlate highly with the development

of anxiety and can be actively reduced in psychotherapy (Riskind, Rector, & Cassin, 2011; Riskind et al., 2017; González-Díez, Orue, & Calvete, 2017). This would be an example of a psychological process – meant for evolutionary benefit as an ability to account for variation in perceived threats – which has become maladaptive due to social factors such as negative life events and circumstances (e.g. abuse), resulting in – or perpetuating – an anxiety disorder (Riskind, Rector and Taylor, 2012). These mediating psychological processes are intrinsically cognitive in nature and therefore can be targeted in cognitive-behavioural therapy (CBT). Mediating psychological processes can be either risk-factors or protective-factors in the pathogenesis of anxiety disorders. CBT can aim to reduce cognitive risk-factors and focus on improving the cognitive protective-factors to mediate the effects of life events and circumstantial factors in the patient's life – developing the individual's strengths and resilience. This helps to formulate personalised cognitive coping strategies for people through a more strengths-based approach. Doing so provides another example of the applicability of cognitive models of explanation for anxiety disorders which the purely biological models do not possess. While biological treatment options take a bottom-up approach by targeting the underlying physiological (neurochemical or hormonal) elements of the psychiatric disorder, psychotherapeutic approaches are able to work from the top-down in a reasonably accessible way. By doing so, the results from evidence-based treatments such as CBT demonstrate significant improvements without directly interfering with the underlying neurochemistry and therefore, psychotherapeutic approaches arguably have a significant advantage over biological approaches.

2.16 The biological explanations of anxiety tend to focus on the hyperactivity of the adrenergic system – responsible for the fight, flight (or freeze) response. There has been much research into this area finding significant results correlating higher levels of anxiety with various biophysical differences to control samples with lower anxiety levels. For example, noradrenaline (NA) is a monoamine neurotransmitter associated with (among many other brain functions) the stress arousal response in the brain and has been found to be relevant in the pathogenesis of anxiety and depression (Goddard, 2010). Goddard (2010) therefore suggests that pharmacological treatments for anxiety and depression – often comorbid diagnoses (see above) – focussing on the adrenergic system could be useful. One important region of the brain associated with anxiety and stress responses (among other emotional processes) is the amygdala. In a recent fMRI study (Robinson, Charney, Overstreet, Vytal and Grillon, 2012), anxiety significantly increased positive connectivity between the dorsomedial prefrontal cortex (dmPFC) and the amygdala, suggesting an aversive amplification system in humans which correlated with trait anxiety. Essentially, this supports the idea of an underlying vulnerability to develop anxiety disorders, pinpoints a neural mechanism in adaptive anxiety and suggests links with its role in maladaptive anxiety. This hyperactivity in the brain can also cause changes in the size of these specific areas and their localised grey matter volume, as suggested by Schienle (2011), who found that those with generalised anxiety disorder (GAD) had significantly higher levels of grey matter in the amygdala and dmPFC than asymptomatic controls. These findings broadly evidence either a predisposition to develop GAD or show consequences of symptoms related to GAD – such as chronic

worrying – on related areas of the brain. Key to the current project is that the directionality of the process is not clear. Instead, a position that these factors operate in a cyclical and iterative process of pathogenesis is clearly stated based on the literature presented here. Support for this model can be found in various biological studies including Laeger et al. (2012) on populations with subclinical anxiety and depression. This suggests a continuum of trait anxiety along which individuals vary and can progress (deteriorate) into clinical levels due to a range of environmental stressors, for example.

2.17 Within the present project, participants are all between the ages of 18-30. This is due to existing research indicating a significant age difference in capabilities of episodic memory and EFT (De Brigard et al., 2016). Therefore, it is important to consider how underlying trait anxiety is expressed differently throughout specific age groups and their corresponding developmental stages. The developmental research into anxiety disorders point to generally transdiagnostic influences, with differential median age of development for specific disorders. According to Norton & Paulus (2017), parental influence appears to be the most significant variable across diagnoses, with specific interest paid to parenting style (overprotective, controlling; see Ballash et al., 2006), characteristics (lack of emotional warmth, childhood adversity and parent-child attachment). Kessler et al. (2005) found that age on onset for anxiety disorders (transdiagnostic) was 11 years, with variation between median age of onset that may reflect other developmental stages. Separation anxiety disorder and specific phobias were common in younger participants (early development), onset of social anxiety disorder peaked in early adolescence, while panic disorder, GAD and agoraphobia showed much later median age of onset and a greater variability. In their summary, Norton & Paulus (2017) argue that the differential median age of onset for discrete anxiety disorders may be reflective of an underlying transdiagnostic anxiety disorder being expressed in relevant developmental stages. For example, separation from a primary caregiver such as a parent, is of particular importance to younger children – and has been included in the DSM-V (APA, 2013) for use in diagnosing children. Further cognitive development is required before one becomes concerned with self-consciousness or how others evaluate you socially – as in social anxiety disorder in adolescents. For the purpose of the current project, GAD is taken as the most relevant anxiety disorder that participants may be approaching clinical significance for (based on psychometric scores on the GAD-7).

2.18 There is a need for an integrative developmental biopsychosocial explanatory model for anxiety disorders that does not explicitly focus on biological factors – as has been the norm for psychiatry – written about passionately by Reid (2007). The wording within Reid's article indicates conflict between the other perspectives in psychology and the 'accepted' biological explanations commonly cited within psychiatry. There is progress towards more integrative models within developments such as Kinderman's (2005; 2009) psychological model of mental disorders. These models are in the early stages of empirical testing however, so results must be treated with caution until a more substantial empirical base is created within the literature to support or refute them. In a critical comparison of explanatory models, it is difficult to determine which features are of primary importance. It could be the applicability of an explanatory model; in which

case, cognitive behavioural models of anxiety disorders could be considered more appropriate due to their constant development and use in therapy. These interventions are not always available to all; however, this is changing in England with the development of the Improving Access to Psychological Therapy (IAPT) scheme. However, the applications from biological explanatory models, such as medications, are more readily available and easily prescribed by GPs, for example. The European Commission's Green Paper on mental health stated that,

"the mental condition of people is determined by a multiplicity of factors including biological (e.g. genetics), individual (e.g. personal experiences), family and social (e.g. social support) and economic and environmental (e.g. social status and living conditions)"

(European Commission, 2005: p.4)

2.19 In reality there is still an imbalance in the accepted biopsychosocial model but this is changing slowly with the progression of research such as Kinderman (2013) and papers explicitly calling for change (e.g., Reid, 2007), demonstrating the need for a more holistic explanatory model for these anxiety disorders. Furthermore, it is important to highlight the developmental transdiagnostic nature of anxiety disorders. The research presented during this thesis posits that trait anxiety fluctuates upon a continuum, and that anxiety disorders reflect the high-end of that spectrum. Therefore, the label of subclinical anxiety is applicable to participants within the present project based on a high level of quantifiable trait anxiety and the absence of current or previous diagnoses or treatment. It is prudent to take into consideration the developmental, biological and cognitive-behavioural influences that may also impact participants' levels of trait anxiety. This is not a strictly homogeneous group, but rather a population who have been objectively divided into groups for the purpose of a quasi-experimental design.

Episodic Future Thinking

Developments in Theory and Research

2.20 As discussed in Chapter One, episodic memory is described by Tulving (2002) as an imaginative neurocognitive function that humans possess. This enables them to vividly remember personal past experiences in great detail. While this takes place in the reality of the mind, Tulving iterates the equivalent importance for humans to physical reality. Most importantly, this human faculty is not simply a passive reconstruction of events from an observer perspective, but rather an image-based re-experiencing.

2.21 Episodic future thinking (EFT) is the phenomena of mentally time travelling to imagine a future scenario, with levels of detail both personal and external to one's self (Suddendorf, 2010; Miloyan, Pachana, & Suddendorf, 2014; Schacter, Benoit, De Brigard, & Szpuner, 2015; Wu, Szpuner, Godovich, Schacter, & Hofmann, 2015; Ward, 2016; Rebetez, Barsics, Rochat, D'Argembeau & Van der Linden, 2016; Bertossi, Tesini, Cappelli & Ciaramelli, 2016). This can – to an extent - be described as the opposite end of the same spectrum of episodic memory. It involves projection into the future instead of the past, and growing bodies of research have found that EFT involves similar cognitive processes and resources to episodic memory (Suddendorf, 2010). EFT is therefore the

cognitive faculty of prospectively experiencing (or pre-experiencing) a future hypothetical event or situation. The level of detail is mainly personal, relates to the individual's perspective and phenomenology of the imagined event, and is not constrained to external details (such as environmental description) from a passive observer perspective (as above). This makes EFT unique, in that it demonstrates the human ability to mentally rehearse and pre-experience events, perhaps to prepare for multiple eventualities. Miloyan, Bulley & Suddendorf (2016) summarize the evolutionary benefit that EFT can provide to humans, from both proximate and ultimate perspectives. They state that the emergence of EFT provided humans with a range of significant benefits over other animals. Specifically, while other animals may respond to imminent or anticipated threat or danger (through immediate anxiety or fear systems), the human capacity for EFT allows us to generate our own predictions of future threats and respond accordingly to minimize risk of harm. In other words, humans generate their own anxiety-provoking prospections – though not always accurately – and these serve to motivate as a call to action (e.g. avoidance of situations) that increase our chance of survival (Miloyan, Bulley & Suddendorf, 2016).

2.22 The affective component of EFT is important to consider, as humans experience emotions related to the event without the event occurring in objective reality at that moment (Lang, 1979; Damasio, 2000; Moscovitch, Chiupka & Gavric, 2013; Ji, Heyes, MacLeod & Holmes, 2016; Bullock, Newman-Taylor & Stopa, 2016; Skodzik, Leopold & Ehring, 2017) and this serves to motivate our actions and behaviours accordingly (Miloyan, Bulley & Suddendorf, 2016). As discussed by Tulving (2002), mental reality is nearly as important to humans as physical reality. When an individual mentally travels back in time to re-experience a personal past event, they have "bent time's arrow into a loop" (Tulving, 2002). One could argue that EFT stretches time's arrow forward beyond the present. The individual is aware that they are not physically present in the memory – it is occurring within their mind – this awareness is known as "autonoetic consciousness" – a meta-cognitive faculty that humans possess. The emotional impact of the episodic memory itself, however, is accessible – much like Damasio's (1999) somatic marker hypothesis. Therefore, when this autonoetic consciousness is applied to prospective thoughts (EFT) it can elicit physical, emotional and somatic markers in relation to the pre-experiencing of the event. Most relevant to the current project is the clinical application of this function in therapeutic interventions. For example, Imaginal Exposure Therapy (Wells & Matthews, 1994; 2014) involves encouraging a patient to imagine gradually more threatening and anxiety-provoking scenarios or stimuli, with support and guidance of a trained clinician. It has shown impressive results in treating anxious patients, and is utilized within CBT practice, which is shown to be the clinical standard for evidence-based psychotherapy approved for treating anxiety disorders.

2.23 Miloyan, Bulley & Suddendorf (2016) state that "episodic foresight is a critical feature of anxiety in humans." It is hypothesized, based on literature of therapeutic interventions such as cognitive behavioural therapy (CBT; Beck et al., 1987; Beck, 1991), that individuals with anxiety will pre-experience more threatening and negative events, including the associated negative (anxious) affect and somatic markers. Wu et al. (2015) found that participants with Generalized Anxiety Disorder (GAD) demonstrated a

negativity bias for future events, rating negative future events as more plausible than asymptomatic controls. They also found that GAD participants benefited significantly less from repetition of future thinking to produce episodic details than asymptomatic controls – particularly for positive events. This finding makes logical sense based on GAD's clinical symptoms of persistent and excessive worry about the future (APA, 2013).

2.24 Anxiety serves an evolutionary purpose for humans, as summarized by Miloyan, Bulley & Suddendorf (2016); analogous to a smoke alarm. Its purpose is to predict threats and trigger avoidant or management behaviours. Broader and more abstract worry is initially advantageous. It facilitates flexible problem-focused coping and encourages the individual to be vigilant to threatening cues. However, this function becomes maladaptive and symptomatic of GAD, when it exceeds its normal application and increases generation of threatening future events. An impact bias becomes present, meaning anxious individuals overestimate the intensity and duration of their negative affective reactions to future events. This becomes more pronounced and problematic when this impact bias does not reduce as a result of multiple mispredictions – i.e. predicted threatening events not occurring (Meyvis, Ratney & Levav, 2010; Miloyan, Bulley & Suddendorf, 2016). Furthermore, from a meta-cognitive perspective, individuals with high levels of anxiety are likely to worry about their own worry – commonly referred to as meta-worry (Hirsc & Matthews, 2012). This meta-cognitive function may in theory rely on the capacity for EFT.

2.25 Episodic memory and EFT rely on common neural networks including the hippocampus and medial temporal lobes (Addis, Pan, Vu, Laiser, & Schacter, 2009; Addis, Wong, & Schacter, 2007; Botzung, Denkova, & Manning, 2008; Okuda et al., 2003; Szpunar, Watson, & McDermott, 2007; Szpunar, & McDermott, 2008; Miloyan, Pachana, & Suddendorf, 2014). Similarly, individuals with damage to their hippocampus demonstrate impaired episodic memory and future thinking (Hassabis et al., 2007; Klein, Loftus, & Kihlstrom, 2002; Tulving, 2002). Furthermore, impairments in EFT can be seen in patients with amnesia (Cole, Morrison, Barak, Pauly-Takacs, & Conway, 2016). It is therefore reasonable to predict that within the present study, participants will activate these areas when constructing future events.

2.26 There have been several conceptualizations and models of episodic future thinking. Most of these conceptual models for EFT focus on the process of "construction" as the key cognitive faculty shared between all types of episodic thinking (episodic memory, EFT and episodic counterfactual thinking) – both past and future. It is important to note, that these models are applicable not just to episodic memory and therefore contain an implicit and explicit assumption that episodic thinking is the cognitive faculty, and that temporal direction (past – future) is simply one continuum within the model.

2.27 The Constructive-Episodic-Simulation (CES) hypothesis states the episodic memory system is used to retrieve and recombine details into a novel future episodic simulation (Schacter & Addis, 2007; Schacter, Addis, & Bunker, 2007; Ward, 2016). Hassabis & Maguire (2007, 2009; Ward, 2016) also proposed that episodic future thinking involves construction of a mental scene. Within their review of episodic future thinking and its possible applications within clinical neuropsychology, Ward (2016) summarises five key cognitive processes involved. These include, "episodic memory, semantic memory,

executive functioning, self-referential processing, and imagery." When combined and utilized together, these faculties create the phenomenon of EFT and allow the individual to pre-experience potential future events.

2.28 The topic of episodic simulation – both EFT and EM – is at the early stages of empirical investigation between relevant (often clinical) groups. There also appears to be some disconnect between research efforts – with most claiming results require replication, but few replications being published. Overarching replicable results show that the episodic core network is functionally implicated during the process of EFT and EM; and that (broadly speaking) these require two main stages: construction/retrieval (early post-stimulus processes) and elaboration (later reconstructive, more imaginative processes).

Cognitive Measures and Methods Used

2.29 The measurement of episodic future thinking at a cognitive level, has mainly involved self-report measures based on adaptations and developments of psychometric measures and interviews. These were originally intended for measuring autobiographical, episodic memory – not specifically EFT. Boyacioglu & Akfirat (2015) state that the psychometric properties of measures for memory phenomenology have been inadequately developed and tested. Most relevant to the proposed study is the Autobiographical Interview (AI; Levine et al., 2002), which originally focused on autobiographical memory by distinguishing internal and external details, and episodic richness of details recalled. The scoring system used in the AI assumes a distinction between episodic and non-episodic facets of autobiographical memory and utilizes categories that were adapted from the Memory Characteristics Questionnaire (MCQ; Johnson, Foley, Suengas & Raye, 1988), which originally distinguished between perceived and imagined events.

2.30 Most widely used within empirical research into episodic future thinking is the adapted autobiographical interview (adapted-AI; Addis, Wong & Schacter, 2008). The adapted-AI utilises the same basic structure as the original AI, however, it incorporates prompts to generate future events as well as remember past events. The scoring system is also the same, in so far as answers are transcribed and then qualitative details are assigned to either episodic (internal) or non-episodic (external) groups. Therefore, an event that described a higher frequency of episodic details is more episodic. Participants who more regularly produce episodic details rather than non-episodic details are also proposed to be more able to retrieve and prospectively imagine events than others. Participants are instructed to recall or imagine an event in four conditions: past few weeks; past few years; next few weeks; next few years. The event does not need to relate to the cue word and participants are encouraged to elaborate and freely associate as they choose to generate their event (Addis, Wong & Schacter, 2008). The scoring system for the adapted-AI relies on analysing the transcripts of interview responses. Information about the central event of each response is categorised as either internal (episodic information that relates to the central event) or external (non-episodic information, including semantic details, information about extended events unspecified in time and place, and repetitions).

2.31 While there is still much need for research into the psychometric properties of the adapted-AI (Boyacioglu & Akfirat, 2015), Ward (2016) suggests that the adapted-AI produces the most detail out of possible EFT measures, and studies have found consistently high inter-rater reliability (Addis, Wong & Schacter, 2008; Mercuri et al., 2015). However, the adapted-AI requires a significant time-commitment for its completion. For example, if 10 events (3 minutes per event) were required per temporal condition (4 in total) then a minimum timeframe for data collection per participant is approximately 120 minutes. Even if the research focused solely on EFT data collection, the timeframe would still be 60 minutes. This presents an issue when utilizing the adapted-AI in EEG research, as there is a recommended timeframe per EEG data collection session. The dense-array EEG Hydrocel 128-sensor net is known to begin drying out after approximately 30 minutes (EGI, 2017). This results in loss of accuracy from readings due to gradually decreasing conductivity on the scalp. Therefore, the adapted-AI will not be utilized within the present study (see Chapter THREE). Instead, a novel two-dimensional scale will be used to gain immediate quantitative self-report data from participants about each cue word. Similar to the adapted-AI, participants are given a cue-word and instructed to remember/imagine an event within the past/next 5 years. The event does not need to be related to the cue word, and participants are therefore allowed to elaborate freely (in their mind). The two dimensions selected also relate to the adapted-AI and aim to measure level of episodic detail produced by scoring the individuals perspective of the event and vividness of the experienced event.

2.32 Recently, psychometric measures have been developed for the purposes of measuring repetitive future thinking as distinctive characteristics within transdiagnostic psychiatric populations, as in the Future-oriented Repetitive Thought (FoRT) scale (Miranda, Wheeler, Polanco-Roman, & Marroquín, 2017). Interestingly, this measure sought to bring together common factors present from a number of established psychometric measures, including the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) and the Generalised Anxiety Disorder Questionnaire-IV (GAD-Q-IV; Newman et al., 2002), which both focus on repetitive and excessive worry and screening for symptoms of GAD respectively. The FoRT Scale (Miranda, Wheeler, Polanco-Roman, & Marroquin, 2017) proposes that future-oriented repetitive thinking is comprised of pessimism, future goals, and positive indulgence. Episodic future thinking can therefore be conceptualised as the faculty that differentiates these three distinctive subtypes. However, this measure still requires further testing and use in research to establish its appropriateness in the current study before being considered a useful tool to measure episodic future thinking distinctively from repetitive future thinking.

Neurobiological Research and the Episodic Core Network

2.33 Neuroimaging studies of episodic future thinking have utilized a number of methods and a variety of technology, beginning with Okuda et al.'s (2003) PET study. Similar activity was reported in neural areas for both future and past tasks, specifically in prefrontal regions, medial temporal lobe, including right hippocampus and bilateral parahippocampal gyri. Overlap between neural regions were replicated heavily in Addis et al. (2007), where both future and past tasks were divided into construction and

elaboration phases. The medial temporal (hippocampus and parahippocampal gyrus) lobe, medial prefrontal cortex, posterior cingulate and retrosplenial cortex, lateral temporal and prefrontal regions were most active across both temporal conditions (Addis et al., 2007; Szpunar, Watson & McDermott, 2007; Schacter, Addis & Buckner, 2007; Addis et al., 2011; Andrews-Hanna et al., 2010; Schacter, Benoit, De Brigard & Szpunar, 2015). This network is referred to herein as the Episodic Core Network (see Table. 1 below). Interestingly, there is a noted overlap between the Episodic Core Network and the heavily researched Default Mode Network (Raichle et al., 2001), which is found to be more active during self-referential and self-projection tasks and when attending to stories containing 1st person pronouns (Gusnard et al., 2001; Kelley et al., 2002; Vogeley et al., 2001; Buckner & Carroll, 2007; Decety et al., 2002; Kjaer et al., 2002; Travis & Parim, 2017). The overlap of neural regions between these two networks makes logical sense in so far as the faculty of episodic thinking involves construction of events that are personal and phenomenological – not passive reconstructions from an external position. This is subjectively related to self-referential processing that would recruit the Default Mode Network as the individual is at the centre of the event.

Episodic Core Network	Brodmann Areas (BAs)
Medial Temporal Lobe: MTL (hippocampus & parahippocampal gyrus)	BA 27, 28, 34, 35, & 36
Medial Prefrontal Cortex: mPFC	BA 9, 10, 24, 25 & 32
Posterior Cingulate Cortex: PCC	BA 23 & 31
Retrosplenial Cortex: RC	BA 29
Lateral Temporal Regions	BA 21, 38, 41 & 42
Prefrontal Regions	BA 8, 9, 10, 11, 12, 13, 14, 24, 25, 32, 44, 45, 46 & 47

Table. 1. – Table showing the key neural regions of the Episodic Core Network and their approximate corresponding Brodmann Areas.

A Note on Episodic Counterfactual Thinking

2.34 When considering episodic thinking as a cognitive faculty, it is important to note the human ability to think "counterfactually" – a distinctly meta-cognitive faculty. Episodic counterfactual thinking is the ability to imagine elements of a past event in a new way that may or may not (according to the individual) alter the remembered outcome of the event (Schacter, Benoit, De Brigard & Szpunar, 2015). For example, if an individual has an episodic memory of their first date with their romantic partner and is asked, "imagine you didn't say X – how might that change what happened?" they are able to think counterfactually by utilising similar reconstructive and elaborative processes to EM or EFT. Their answer may be that the date ended the same way (no change to outcome of event) but they were able to construct an alternative narrative for what could have happened, retrospectively. While there has been an increase in research investigating

episodic future thinking and memory and their shared core neural network (Schacter et al., 2012), there has been less research into episodic counterfactual thinking until recently (Addis et al., 2013). Studies into the vividness of episodic counterfactual thinking and episodic future thinking have found that participants often report less affective significance when imagining events in general compared to recalling episodic memories; however, this was more pronounced in episodic counterfactual thinking (De Brigard & Giovanello, 2012). This means that imagining a future event is less emotionally intense for individuals than recalling a past episode; this is reduced further when imagining an alternative version of a past episode. The valence of these events made no significant difference to ratings of vividness or specificity of details produced, and therefore the emotion associated had no mediating effect of this process. In general, remembered events are more vivid than imagined ones (D'Argembeau & ven der Linden, 2004). Interestingly, repeated simulation of counterfactual episodes does not increase their subjective plausibility (Szpunar & Schacter, 2013) despite other studies showing counterfactual simulations can lead to memory distortion (Gerlach et al., 2014). Therefore, a debate still exists in the literature with regard to the role of repeated episodic counterfactual thinking in memory functioning and distortion.

2.35 The role of episodic counterfactual thinking in therapy is an important issue to consider for future clinical research. Ferrante et al. (2013) found that participants often focus on uncontrollable factors when asked to think counterfactually about their failings (in completing a puzzle). Comparatively, participants who were encouraged to think prospectively about how to succeed with this task in future demonstrated a tendency to focus on controllable factors for constructive improvement. This bares interesting applications in understanding the role of reflection in the therapeutic process. It is an opportunity to constructively reflect on past failings or negative experiences and to focus future cognitions on overcoming the event in a controllable and non-ruminative way. Indeed, the role of episodic counterfactual thinking as a subject for future research is important to note within the present project. If differences are found to exist between High Anxiety participants and asymptomatic controls when producing episodic future thoughts, it may call for research investigating differences in episodic counterfactual thinking as well (see Chapter FIVE for discussion).

Summary

The current literature available at this time suggests the following key findings:

1. Persistent negative (threatening) future-thinking (worry) is a main defining characteristic of Generalized Anxiety Disorder (GAD)
2. Subclinical Anxiety (high trait anxiety) is highly predictive of GAD, and both cognitive and neurophysiological differences exist in subclinical populations
3. Episodic thinking is made up of episodic memory, future thinking and counterfactual thinking and each share the Episodic Core Network of neural regions while remaining distinct
4. Episodic future thinking is related to worry (as above) in GAD

5. There are cognitive differences in episodic future thinking between participants with GAD and asymptomatic controls

2.36 Taking into account the above findings, neurocognitive theory can be applied to begin hypothesizing about how these cognitive differences may be related to neural regions and networks. The Episodic Core Network described above (see Table. 1.) is therefore important to consider when planning the analyses for such an investigation. So to, are other neurobiological correlates of threat detection in anxiety outlined by Hofmann, Ellard, & Siegle, (2012); Zaretsky, Mendelsohn, Mintz, & Hendler (2010); and Wheelock et al. (2014); and attention-bias for affective stimuli. How these networks interact when engaging in EFT is key to understanding potential differences in the mental prospection of adults with anxiety. Therefore, the study presented below will investigate these potential neurocognitive differences in formulating affective episodic future thoughts by comparing a subclinical group to asymptomatic controls – the first study of its kind.

2.37 Chapter THREE outlines the methodology used within the present study and provides a critical discussion surrounding participant recruitment, quasi-experimental design, EEG, source estimation and the inverse problem, and ethical considerations within the project.

Research Questions:

1.) Is there a statistically significant difference between High Anxiety and Asymptomatic Control groups' self-report ratings of Episodic Future Thinking

Scores obtained from the self-report measures of EFT will be combined to make 4 separate EFT scores – Total, Negative, Positive and Neutral. These EFT scores are made by combining scores from the two questions that measure, a.) level of detail, and b.) perspective of the event.

2.) Will there be any statistically significant neurophysiological differences (as measured by EEG) between High Anxiety and Asymptomatic Control groups during Episodic Future Thinking tasks?

Mean amplitude during both time windows (275-325ms and 775-825ms) will be statistically analysed for potential differences at key electrode sites between groups during EFT tasks.

3.) Will there be any statistically significant differences between High Anxiety and Asymptomatic Controls in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Episodic Future Thinking tasks?

sLORETA data for regions of the Episodic Core Network will be analysed to investigate potential statistically significant differences between groups.

3a.) If any statistically significant differences are found (as above), is there a significant interaction between Anxiety Group and Valence of cue word?

A 2 (Anxiety group: High vs Low) x 2 (Valence: Neutral vs Negative) ANOVA will be completed to investigate potential statistically significant interaction effects of Anxiety Group and Valence on recruitment of neural regions comprising the Episodic Core Network during EFT tasks.

Hypotheses:

1.) There will be a statistically significant difference between High Anxiety and Asymptomatic Control groups' self-report ratings of Episodic Future Thinking
2.) There will be significant neurophysiological differences (as measured by EEG) between High Anxiety and Asymptomatic Control groups during Episodic Future Thinking tasks
3.) There will be significant differences between High Anxiety and Asymptomatic Control groups in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Episodic Future Thinking tasks

3.0. CHAPTER THREE: Methodology

Participant Recruitment

Sampling Methods

3.1. For the purpose of the current project, self-selecting sampling techniques are utilised; specifically snowball sampling. This allows self-selected participants to recommend the study to their friends, family or colleagues, for example. This technique is useful when conducting research that requires a bigger time commitment and one that can gain a lot of data from a smaller sample size. It has also traditionally been utilised to study "hard-to-reach" populations, such as current or previous drug users (Eland-Goossensen et al., 1997; Water, 2015) or childhood sexual abuse victims (Al-Modallal, 2015). The limitation of snowball-sampling is the increased levels of bias that may possibly contaminate the results. For example, social proximity or closeness of relationships may signify other shared factors and variables between participants in a specific subgroup – they may share significant common interests and characteristics. This causes an issue when drawing causal conclusions based on the results of the statistical analysis because each of these unidentified factors may account for a portion of variance otherwise not specified (Emerson, 2015). Further statistical investigation has produced evidence that snowball-sampling can be useful in generating information about specific populations, and steps can be taken to adjust for social homogeneity by examining participants' social media groups (see Rocha, Thorson, Lambiotte, & Liljeros, 2017). Snowball-sampling can be used to reach higher numbers of "hard-to-reach" populations, this is particularly useful in studies that require large samples that bolster more statistical power for generalisation to wider populations (Emerson, 2015). However, within the current project, the number of participants required is lower due to the richness of data obtained per EEG data collection session. The number of participants for similar neurophysiological studies range significantly from N = 15 (Massand & Bowler, 2015) to N = 33 (Hach, Tippett & Addis, 2014). This is indicative of a larger issue within neuropsychology research. Namely, the inconsistency between researchers in their reporting of effect sizes or statistical power obtained within the sample. In a systematic review of 100 EEG and ERP studies, Larson & Carbine (2017) found that such inconsistency made it practically impossible for recommendations to be made for future research design; and limited the ability to determine whether studies were adequately powered to detect effects of the manipulated independent variables. Therefore, there is no current guideline for sample size in EEG or ERP research – nor have any such recommendations been made for EFT research.

3.2. While snowball sampling is normally referred to as a form of opportunity sampling, steps were taken to inform the selection of participants through a self-selective protocol. Specifically, the study was advertised using a poster asking for participants to take part in a neuropsychology project related to worry. Participants were encouraged to e-mail the researcher if interested and were then asked standardized questions for screening via e-mail to establish their suitability for the present study. Furthermore, only

participants who met the criteria for the study were asked to suggest the study to their friends, family or colleagues – this was the way in which significantly relevant factors were controlled for during snowball sampling. The selection criteria for the study were clearly specified on the poster. Selection criteria were as follows: i.) no current or previous diagnosis of mental disorders; ii.) no experience of psychological therapy for anxiety or depression; and iii.) no previous or current use of medication (psychopharmacological interventions) for depression or anxiety. This sampling method and exclusion criteria closely match those found in Mercuri et al. (2015) and Rebetez et al. (2016). The study was advertised using posters across the University of Gloucestershire campuses; on social media (Facebook) pages for the university; and also advertised to the general public across social media; and in local businesses. These participants may have known other friends and colleagues who shared their interests and were likely to take part. This occurred a number of times during participant recruitment for the project – 4 of the 11 EEG participants and 6 of the 16 overall participants were known to other participants and reported they volunteered because of their recommendations.

Quasi-experimental Between-Participant Design

3.3. Participants were divided into two experimental conditions based on their general level of trait anxiety and worry: Subclinical Anxiety and Asymptomatic Controls. To do this, self-report measures for anxiety and worry were examined for their psychometric properties and appropriateness when applied to the current project. One such clinical tool is the GAD-7 (Spitzer, Kroenke, Williams & Lowe, 2006). This brief measure of Generalized Anxiety Disorder (GAD) was originally developed in line with the 4th edition of the Diagnostics and Statistics Manual (DSM-IV; American Psychiatric Association, 1994), which is used by clinical psychologists and psychiatrists to diagnose mental disorders; now the DSM-V (APA, 2013). The measure was developed as a brief alternative to lengthy clinician-administered measures and interviews that were previously used in practice. It was based on a sample of 2739 participants (65% female; 80% White, non-Hispanic). The measure has excellent internal consistency (Cronbach α = .92), good test-retest reliability (intraclass correlation = 0.83) and good procedural validity (Spitzer, Kroenke, Williams & Lowe, 2006). The scale scores 7 items from 0-3 resulting in a total GAD-7 score of 0-21. With a cut-off point of 10 or greater, sensitivity and specificity exceed 0.80. A cut-off point of 15 or greater indicates severe GAD. The measure has good construct validity, as it demonstrated a strong correlation between GAD severity and a range of other measures for: mental health (0.75), social functioning (0.46), general health perceptions (0.44), bodily pain (0.36), role functioning (0.33), and physical functioning (0.30) (Spitzer, Kroenke, Williams & Lowe, 2006). It also shows good convergent validity by correlating with other anxiety scales, the Beck Anxiety Inventory (r = 0.72) and the anxiety subscale of the Symptom Checklist-90 (r = 0.74). This scale has also been examined in a number of populations to investigate cultural biases (80% of the original sample were White). For example, Parkerson, et al. (2015) investigated these biases and found that Black/African American participants score lower on items 1,5 and

7 of the GAD-7 than others with similar symptoms and this suggests a need for a culturally sensitive GAD-7 due to differential item functioning.

3.4. The GAD-7 has been found to show good psychometric properties in German (Hinz, et al., 2017), French (Micoulaud-Franchi, et al., 2016) and American populations (Spitzer, Kroenke, Williams & Lowe, 2006). It shows poor psychometric properties in Lebanese outpatient samples (Sawaya, et al., 2016) suggesting a possible "Western culture bias" present within the measure's items. However, the GAD-7 has been successfully adapted with positive results for Chinese populations (Tong, et al., 2016) so this is unclear. The GAD-7 is also used across England in the NHS Improving Access to Psychological Therapies (IAPT) scheme, which aims to provide a stepped-care model of evidence-based psychological therapy to the general population. Within the IAPT services, the GAD-7 is used as an outcome measure for treatment success rates (IAPT, 2008; IAPT, 2017). Therefore, after consideration of the above empirical evidence, the GAD-7 is deemed appropriate for use within the current project. It has strong psychometric properties and is already used for national research across England.

3.5. The Penn-State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) is a 16-item self-report questionnaire which aims to assess respondents' level of pervasive and uncontrollable worry – a defining characteristic of GAD (APA, 1994). The total PSWQ scores range from 16-80 (5 point Likert-scales are used for each item) and it has been found to have high levels of internal consistency (α range = .86–.93) but varying levels of test–retest reliability (r range = .54–.92) (Brown, Antony, & Barlow, 1992; Meyer et al., 1990; Stanley, Novy, Bourland, Beck, & Averill, 2001, Dear, et al., 2011). The PSWQ has also been tested cross-culturally and found to have high internal consistency, good test-retest reliability and good convergent-divergent validity in Argentinian populations (Rodríguez-Biglieri & Vetere, 2011); and Japanese American and European American (Watari & Brodbeck, 2000) populations. Furthermore, Scott, Eng & Heimberg (2002) found that nonclinical Caucasian, African American and Asian American populations did not differ significantly in their scores on the PSWQ or the frequency they met clinical criteria for GAD. This suggests that the PSWQ is cross-culturally reliable in measuring individuals' level of trait worry, and how it may constitute a diagnosable level of trait anxiety. However, the study also found that these groups differed significantly on the domains their worries were related to. This was based on scores from the Worry Domains Questionnaire (WDQ; Tallis et al., 1992), which measures the intensity of worry across five specific categories: Relationships, Lack of Confidence, Aimless Future, Work Incompetence, and Financial. Significant differences were found both between and within groups, which demonstrates the variability between nonclinical ethnic groups. However, this study further demonstrates the broad nature of pervasive worry that is captured using the PSWQ.

3.6. Behar et al. (2009) have suggested that a cut-off score of 65 provides the best balance of sensitivity (0.99) and specificity (0.98) when utilising the PSWQ to diagnose GAD symptoms. Therefore, within the present study, participants can be grouped into a "High Worry" (PSWQ = > 65) condition. Some research has highlighted multiple distinct classes of worry from the PSWQ, specifying cut-off scores of 39-54 as "moderate-high worry" and under 39 as "low worry" (Korte, Nicholas, & Schmidt, 2016).

3.7. For the purposes of the experiment, these two measures will be used to establish two groups: “Subclinical Anxiety” (GAD-7 > 10; PSWQ > 65) and “Asymptomatic Controls” (GAD-7 < 10; PSWQ < 39). They have been selected for their strong psychometric properties and reliability in measuring trait anxiety and levels of pervasive worry, respectively. Therefore, the quasi-experimental independent variable (IV1) will be participants’ anxiety group. The subsequent statistical analyses will investigate the differences (both cognitive and neurophysiological) between these two groups when performing the EFT tasks (see below). Both of these psychometric measures are completed through the NOVOPsych App for iPad (see Appendix D for examples), which allows for scores to be automatically generated and for data to be both passcode and password protected.

3.8. Alternative methods could have included the Depression, Anxiety and Stress Scales – short version (DASS-21; Lovibond & Lovibond, 1995). This self-report measure provides a summary of scores for three dimensions of mental health. It has been studied across Western (USA and UK) and Eastern European (Russia and Poland) countries and demonstrated appropriate fit as a psychometric tool (Scholton, Velten, Bieda, Zhang & Margraf, 2017). However, this was not chosen to measure anxiety and worry because it was felt to not be specific enough to answer the proposed research question, and has been found to load onto a more general measure of negative affect (NA) in non-clinical samples (Henry & Crawford, 2005). There is clearly some investigation required, as DASS-21 total scores correlate better with co-morbid anxiety and depression than their respective single dimension scores (Osman et al., 2012); suggesting an underlying factor (possibly NA) that the measure total fits better than its component subscales. It calls to question the specificity of these subscales but does illustrate the utility of the DASS-21 as a brief measure that elicits rich overall data from a trifactor model. This is not necessarily appropriate for the current study, and therefore more specific and clinical measures have been chosen that were designed with the purpose of measuring GAD symptomology.

3.9. The quasi-experimental IV1 is the group to which participants are assigned based on their GAD-7 and PSWQ scores. However, the second independent variable (IV2) is the valence of the affective stimuli presented during the task. Broadly speaking, there are three groups of affective stimuli: positive, neutral and negative. For each of these valence conditions, a level of arousal is associated with the stimuli – the intensity of emotion the stimuli elicit within participants. Tools have been developed in order to standardise affective stimuli for their valence and arousal, for use within psychological research. For the purpose of the present study, cue words were selected from the Affective Norms for English Words (ANEW; Bradley & Lang, 1994) which has previously been used within neurocognitive research by Mercuri et al. (2015) investigating EFT within opiate-using populations. The ANEW words have standardized ratings that were established using the Self-Assessment Manikin (SAM), an affective rating system developed by Lang (1980) that has pictorial representations with corresponding bi-polar rating scores for valence (positive-negative), arousal (high-low) and dominance (in control-dominated). Other such affective stimuli have been developed to be presented pictorially (as in IAPS; Lang et al., 2008); aurally via digitised sounds (as in IADS; Bradley

& Lang, 2007); and in longer forms of prose text (as in ANET; Bradley & Lang, 2007). Each of these affective stimuli are standardised for their valence, arousal and dominance using the SAM.

3.10. The cue words for the present study were selected from the "all subjects" list of ANEW (Bradley & Lang, 1999), to ensure they were suitable for a range of participants. They were matched for both valence and arousal ratings to control their equivalence as representations of each stimuli valence condition (positive, neutral and negative). An illustrative example of a negative-high arousal word from ANEW would be "Assault" which has a valence rating of 2.03 (SD = 1.55) and arousal rating of 7.51 (SD = 2.28). Note that scores for each dimension are out of a maximum score of 10 – the lower the valence rating, the more negative and vice versa. The opposite applies for arousal, whereby the higher the score, the higher level of emotional arousal is experienced. To ensure comparative valence, cut off points for negative valence will be set at = < 3 and positive valence at = > 7. Both valence conditions will have arousal scores = > 6.5 to control for this effect. Control conditions (neutral) will be selected at valence ratings ranging between 4.5-5.5 and arousal ratings = < 5. The aim will be to gain comparative data of emotionally neutral words that do not elicit a strong emotional reaction within the participant. This will prove vital in later analyses investigating possible differences based on the valence of the cue words. However, there remains an issue. Schneider et al. (2016) highlight the potential problems with assuming that mid-point affective stimuli are in fact reflective of "neutral" valence. Specifically, they posit that stimuli which falls between the two extremes (positive and negative valence) are potentially ambivalent stimuli – not affectively neutral. Therefore, they elicit a combination of positive and negative emotion from the participant, and to assume this synonymous with neutral – which denotes no reaction or baseline – is problematic. It may limit the experimental control within studies – Schneider et al. (2016) found neutral images elicit ambivalence, but with a small sample (N = 41). Further research needs to investigate the potential conflation of neutral valence and ambivalent stimuli.

3.11. The current research into EFT relies commonly on affective cue words for their stimuli (e.g. Mercuri et al., 2015); although use of pictorial stimuli has been used to reinforce context in other studies into episodic memory (Bramão, Karlsson & Johansson, 2017). This may be due to the vagueness of such a stimulus. Participants are able to produce episodic prospections and memories, using the cue word as a starting point from which they elaborate. When the context is reinforced, the level of episodic detail increases. However, this presents another experimental manipulation that does not lend itself to initial investigations such as this.

3.12. To control for order effects, the presentation of cue words was counterbalanced for temporal condition, while randomly generating the valence condition. For example, all cues for "past" temporal conditions were presented before the "future" temporal conditions – and vice-versa. However, the valence of words was randomly ordered using e-Prime 2.0 software. This procedure has been utilized within previous research into episodic memory and future thinking because it is believed to control for the cognitive load on participants that could be caused by switching between temporal conditions (Addis, Wong & Schacter, 2008; Mercuri et al., 2015). Such cognitive load could decrease

the level of episodic detail produced by participants, and this may be reflected in their neurophysiological activity.

	Valence	SD	Arousal	SD
Positive	8.08	1.17	6.29	2.14
Neutral	5.07	1.25	3.71	2.06
Negative	2.14	1.55	7.12	2.33

Table. 2. – Cue words from ANEW: Mean Valence and Arousal ratings with corresponding Standard Deviations

EEG, ERP vs. sLORETA and the Inverse Problem

3.13. The development of neuropsychology can be broadly grouped into two increasingly interactive bodies of research that both have corresponding methodologies and instruments. Borck (2016) describes these as "imaging" and "writing" approaches. Imaging approaches utilise neuroimaging technologies such as magnetic resonance imaging (MRI) and electroencephalography (EEG) to specifically investigate "localisationism" - the assumption that specific human faculties are localised to areas or networks in the brain. Writing approaches, however, focus on the process and activity of the brain, utilising neurophysiological measures similar to the imaging approaches. The visualisation of this data is traditionally in the form of charts with traces generated, focussed on time-constraints. For example, event-related potentials (ERPs) are a useful way of measuring a time-locked neurophysiological reaction to a stimulus (Kropotov, 2016). Put simply, imaging is focussed on the structural, while writing is focussed on the functional. These two fields yield various information and also interact to form functional neuroimaging research, which is quickly becoming the leading hybrid within neurosciences. Examples of this include fMRI-informed-EEG (and vice versa) methodologies, which involve improving the accuracy of the functional information obtained through EEG with personalised high resolution anatomical and structural information obtained from fMRI (Cottereau, Ales, & Norcia, 2015; Ou, et al., 2010). The proposed research questions fall within localisationism, but between imaging and writing approaches as defined by Borck (2016). Neurobiological correlates to cognitions are functional, and time-constrained phenomena, and therefore integrate the imaging and writing approaches to neuropsychological research. From this epistemological position, it is possible to measure the pattern of neurological activity within discrete and interacting neural networks in response to specific stimuli and make analogous discussions related to cognitions within cognitive theory.

3.14. Electroencephalography (EEG) is the study of electrical potentials distributed across regions on the scalp as a result of neural activity within the brain. The distribution of electrical potentials (measured at the scalp) arises from the synchronised synaptic activity in populations of cortical neurons (brain cells) and excitation of dendrites of multiple pyramidal cells in the cerebral cortex. This produces a somewhat localised

current flow (if the number of neurons is great enough) that is measurable at the scalp level (Teplan, 2011; Jackson & Bolger, 2014). Cumulatively this process results in small individual signals (action potentials) that are detectable as small variations (microvolts - μV) in activity as measured on the scalp. Important to note are the variations in neurons position, and their positive or negative synchronicity – see Fig. 1. below.

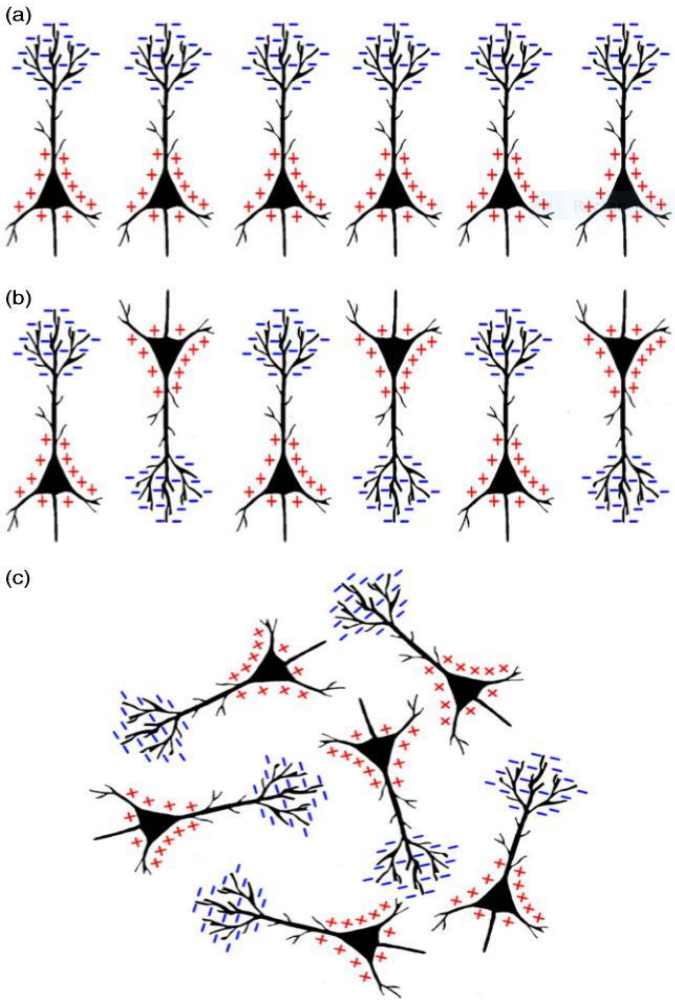


Fig. 1. – illustrative example of neuronal synchronicity and differences in position: (a) Clusters of neurons positioned with negative charges facing upwards (towards the scalp surface) will be best measured by EEG. (b)Clusters of neurons that fire positive and negative signals will cancel each other out, and not be measurable at the scalp. (c) Neurons positioned in a way that is not parallel to the scalp will cancel each other out and not be measured (Jackson & Bolger, 2016)

3.15. The positive or negative charges that are detected at each sensor site are measured and this scalp potential is analysed for its variation from common reference points – giving an indication of its individual reading relative to the grand average of activity at that time (measurable to milliseconds resolution – 1ms). Within the present project, the vertex point (marked as Cz on the EEG 128-sensor nets) was pre-marked on each participant's scalp in relation to the nasion, inion, and pre-auricular clefts (Catherwood, et al., 2014). Historically, most EEG polygraphs in the 1950s era had no more than eight

channels and there was no video EEG monitoring available, yet still it was used as a neurodiagnostic tool while neuropsychology moved away from lesion-directed surgery (Loring, 2010). Use of dense-array EEG 128-sensor nets – as in the current study – provides higher spatial resolution when measuring the sources of potentials compared to traditional sensor nets. This is because the space between electrodes is smaller, and the number of reference points is higher – allowing for better analysis of individual variations in μV. One issue remains, which is that sources of electrical activity are often deep within the brain and there are interpersonal variations between participants. For example, in their skull thickness, brain folds and structures of cortices and grey matter – all these factors limit the accuracy of readings when trying to infer a source. Furthermore, the inverse problem remains.

3.16. The inverse problem arises because action potentials from deeper areas (subcortical regions) will be measured across *all electrodes* in varying levels, and that physical interference is difficult to account for. In short, each electrode on the scalp will record potentials from an unknown and potentially large number of sources – not specific to their location. This creates an unknown number of possible sources for these electrical potentials and poses an issue with localising their respective sources (Vendel et al., 2009). Complex formulae have been developed and are applied to resolve this problem – commonly known as the forward solution. One such forward solution is standardised low-resolution electromagnetic tomography (sLORETA; Pasqual-Marqui, 2002). sLORETA seeks to analyse a low-resolution construction of source potentials in 3D space – tentative source estimation is therefore possible, though not at the spatial resolution of fMRI. As a technique, it is robust against noise and its localisations are less bias towards superficial sources resulting in more power to detect deep subcortical areas (Ghumare, Schrooten, Vandenberghe & Dupont, 2018). Considering the aim of the present study, to identify neurophysiological differences during EFT between groups, it is important to utilise a reliable source estimation technique. In their comparative source estimation study, Hedrich et al. (2017) found that other linear methods (minimum norm estimation – MNE; dynamic Statistical Parametric Mapping – dSPM) and the non-linear method (coherent Maximum Entropy on the Mean – cMES) provide similar source estimations to within approximately 1mm accuracy. sLORETA is the most powerful of the source estimation methods available within the Geosource (EGI Software) program, and so was utilised within the present study to obtain accurate results. sLORETA is able to produce data that infer the intensity of activity at a given neural region at a specific time – or averaged across a selected time-window. These data will be used within the current project to specify which regions of interest are most intensely recruited during episodic future thinking in each group. However, Pascual-Marqui (2002) specifies that these results are pseudo-statistics and advises against their use in hypothesis testing. Therefore, visual representations produced by sLORETA techniques (mapped onto a standardised MRI) will also be used to illustrate potential differences between groups and tentative conclusions will be drawn from their concurrent results.

3.17. To guide the selection of time windows of interest during analyses, event-related potentials (ERPs) are referenced within the present study. Several ERPs are related to episodic memory and EFT. Specifically, the Late Positive Component (LPC), which occurs

approximately 500-800ms after stimulus onset. It has been implicated in episodic memory and the strength of memories reported; furthermore, it relates specifically to self-knowledge compared to knowledge of others (Coronel & Federmeier, 2016). The second ERP to be examined is the P300 – a positive potential that occurs approximately 300ms after stimulus onset. It has been related to a range of affective processing tasks, and the allocation of attentional resources (see Polich, 2007). However, it is also implicated in the retrieval of semantic information (Kotlewska & Nowicka, 2015). To this end, two 50ms time windows are selected: (a) 275-325ms, and (b) 775-825ms after stimulus onset. It is thought that mean amplitude during these time windows will provide rough indications of differences in initial encoding or retrieval of semantic information, and formation of episodic memory or prospection, respectively.

Ethics

3.18. This project underwent a rigorous ethical approval process via the University of Gloucestershire's research ethics panel (approval obtained 23/06/2017). All suggestions and critiques were adhered to throughout the project to maintain high ethical standards with regards to confidentiality, deception and both participant and researcher safety.

3.19. Ethical considerations for this project are complex and subtle. The British Psychological Society Code of Human Research Ethics (BPS; 2014) dictates that participants must be informed of their full involvement in the study and any information which must be withheld due to its potential to impact on the results of the study must be disclosed at the earliest possibility. Information about the independent variable (trait anxiety) will be detailed in the written debrief, given immediately after completion of the study to minimize deception. Furthermore, some participants within the proposed study are likely to have high levels of anxiety without a diagnosis. While this alone does not constitute clinical eligibility for diagnosis of an anxiety disorder, it does mean they may be more vulnerable to the effects of emotional stimuli used within the study. The affective stimuli suggested above from the ANEW are carefully selected to limit their possible negative effects on highly anxious participants when compared to other cue words that could have been selected. Negative valence cue words were limited to a rating of > 2, which prevents potentially upsetting words being used. Furthermore, GAD-7 and PSWQ scores are not made available to the participants, as this could potentially cause further distress to those who scored highly on either measure. This decision was made in conjunction with suggestions from the Research Ethics Panel and the researcher's supervisory team, as a way of minimising risk of potential distress to participants.

3.20. Participants' anonymity was insured by use of participant numbers. Once they had read and signed the consent form, they were given a number that was linked to their data. This number was used for the GAD-7 and PSWQ questionnaires; and during the EEG data collection process. Therefore, the participant's name was not utilised anywhere else during or after data collection. Participants were given a written and verbal debrief, stating their participant number and informing them of their ability to withdraw their data from the study within 4 weeks of data collection – with no negative consequences (see Appendix C).

Summary

3.21. The above methodology and procedure aims to examine the neurocognitive differences between Subclinical Anxiety participants and Asymptomatic Controls. This is a complex quasi-experimental design with a high level of control over possible extraneous variables that may impact results. For example, this design controls for the effect of the cue words' valence by randomizing their presentation and analysing data from across all valence-temporal conditions. This study is not concerned with the valence of the EFT produced, but with the neurological process involved with producing them and how this may differ due to trait anxiety. It is important to consider the amount of data that will be obtained from this design, and how this will be used to further isolate the dependent variables of a.) cognitive scores of EFT (rating scales), and b.). neurophysiological activity and its sources at P300 and LPC.

3.22. Chapter FOUR presents a full account of the study, including procedure, descriptive statistics and results at each level of analysis; cognitive, EEG, and sLORETA. Chapter FOUR concludes with a summary of the findings before Chapter FIVE presents a critical discussion of these in relation to each of the hypotheses in turn.

4.0. **Chapter FOUR – The Study**

4.1. This chapter will present the experiment conducted to investigate the research questions posed. Not all participants who completed the experiment did so while EEG readings were being taken, therefore the analysis is divided into Cognitive (N = 16) and EEG (N = 11) sections.

Research questions:

1.) Is there a statistically significant difference between High Anxiety and Asymptomatic Control groups' self-report ratings of Episodic Future Thinking
2.) Will there be any statistically significant neurophysiological differences (as measured by EEG) between High Anxiety and Asymptomatic Control groups during Episodic Future Thinking tasks?
    a. If any statistically significant differences are found (as above), does this remain significant when controlling for the effect of the cue words' Valence?
3.) Will there be any statistically significant differences between High Anxiety and Asymptomatic Controls in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Episodic Future Thinking tasks?
    a. If any statistically significant differences are found (as above), is there a significant interaction between Anxiety Group (High vs Low) and Valence of cue words?

Participants

Cognitive:

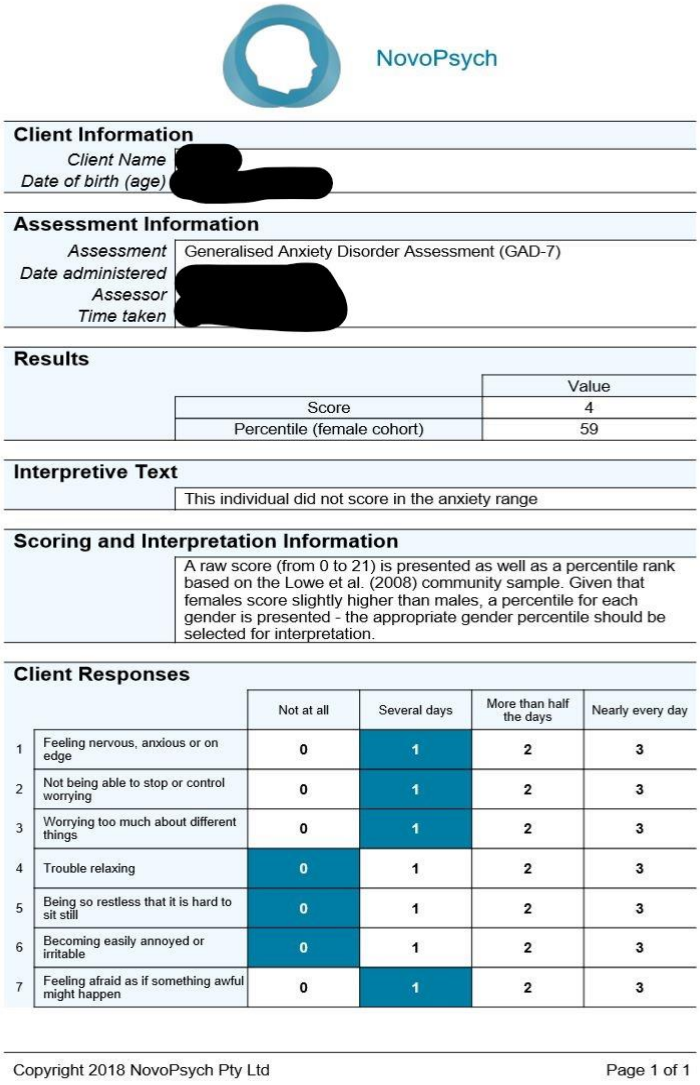
4.2. Participants were N = 16 self-selecting volunteers (8 Men, 8 Women; *M* = 23.8 (SD = 2.9) years, age range: 11 years) recruited using posters and social media. Snowball sampling was utilised – participants were encouraged to recommend the study to like-minded friends, family or colleagues. This resulted in recruitment of N = 6 participants known to at least one other participant. Participants completed two psychometric measures of anxiety and worry – the GAD-7 and PSWQ. Results from these questionnaires were used to divide participants into High Anxiety (N = 10) and Low Anxiety (N = 6) groups. There was a significant effect for Anxiety Group on GAD-7 scores, $t(14) = 5.37$, $p < .001$; and PSWQ scores, $t(14) = 8.51$, $p < .001$. High Anxiety participants scores (*M = 14.20, SD = 4.24); M = 63.10, SD = 6.40)* on measures of trait anxiety were therefore significantly higher than Low Anxiety (*M = 4, SD = 2.37; M = 36.50, SD = 5.36)* participants, suggesting a meaningful difference between groups.

EEG:

4.3. Participants were comprised from the total sample of 16 participants above. N = 11 (4 Men, 7 Women; *M* = 23.8 (SD = 2.65) years, age range: 10 years) were recruited as above. Participants completed two psychometric measures of anxiety and worry – the GAD-7 and PSWQ. Results from these questionnaires were used to divide participants into High Anxiety (N = 6) and Low Anxiety (N = 5) groups. All participants were asked to

bring corrective eyewear if needed, resulting in *normal* or *corrected to normal* vision for all participants.

4.4. Participants were given a written consent form which clearly described the experiment, explained their right to withdraw at any time with no negative consequences and prompted them to ask the researcher if they had any further questions (see APPENDIX B). Participants were then assigned a number to anonymise their data records. Following the study, participants were provided with a standardised written debrief (see APPENDIX C) and a verbal debrief where they had the opportunity to ask further questions. Participants were instructed to complete two psychometric questionnaires using the NOVOPsych app for iPad – GAD-7 and PSWQ. Participants' demographic information was recorded using NOVOPsych and records were anonymised by using the corresponding participant number. All results and records were electronically secured using both passcodes and passwords known only to the researcher.



NovoPsych

Client Information

Client Name [redacted]
Date of birth (age)

Assessment Information

Assessment Generalised Anxiety Disorder Assessment (GAD-7)
Date administered [redacted]
Assessor
Time taken

Results

	Value
Score	4
Percentile (female cohort)	59

Interpretive Text

This individual did not score in the anxiety range

Scoring and Interpretation Information

A raw score (from 0 to 21) is presented as well as a percentile rank based on the Lowe et al. (2008) community sample. Given that females score slightly higher than males, a percentile for each gender is presented - the appropriate gender percentile should be selected for interpretation.

Client Responses

		Not at all	Several days	More than half the days	Nearly every day
1	Feeling nervous, anxious or on edge	0	1	2	3
2	Not being able to stop or control worrying	0	1	2	3
3	Worrying too much about different things	0	1	2	3
4	Trouble relaxing	0	1	2	3
5	Being so restless that it is hard to sit still	0	1	2	3
6	Becoming easily annoyed or irritable	0	1	2	3
7	Feeling afraid as if something awful might happen	0	1	2	3

Fig. 2. – Screenshot of GAD-7 results summary as presented on NOVO Psych iPad App

4.5. Once participants had completed the questionnaires, a message appeared prompting them to hand the iPad back to the researcher. Following this, the results (see Fig. 2. above) were e-mailed to the researcher using a passcode protected and encrypted link (see Fig. 3. below).

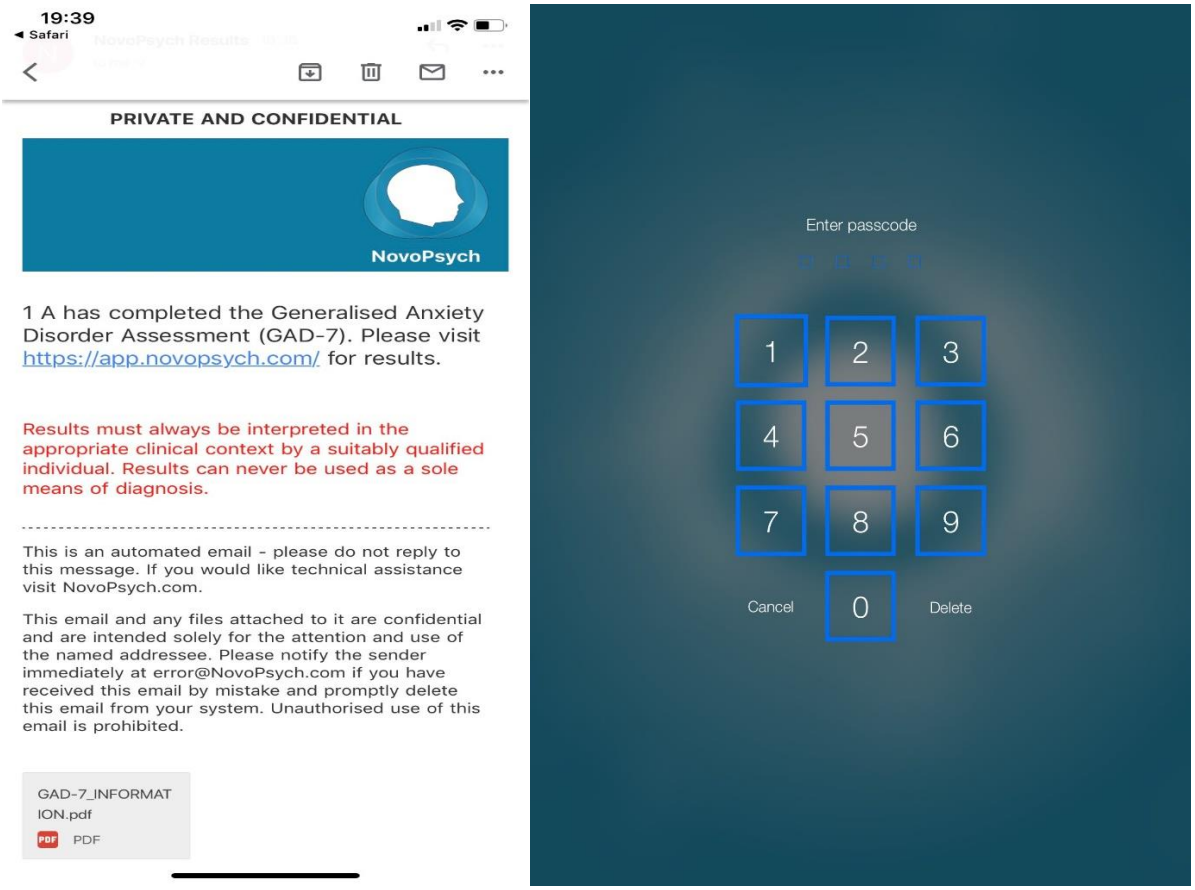


Fig. 3. – Screenshots of NOVO Psych iPad app results e-mail and password protection

4.6. Following completion of the GAD-7 and PSWQ, participants completed a task as presented to them on a display monitor using e-Prime 2.0 software. Participants were instructed to imagine a future event/remember a past event within the next/past 5 years and were presented with a cue word. The task comprised of two temporal conditions (Past vs Future) and three cue word valence conditions (Positive, Neutral, Negative), as described above (see Chapter Three). Cue words were presented in random order, and the tasks temporal condition was counterbalanced for each participant to control for order effect and cognitive load. For example, Past x Positive, Neutral, Negative – followed by – Future x Positive, Neutral, Negative (and vice-versa). There were 54 cue words in total, resulting in 9 per temporal-valence condition. Following each Cue Word presentation, participants were instructed to rate their imagined/remembered event for level of detail and perspective – two indicative measures of episodic thought. Participants were given an opportunity to practice the task with 3 EFT tasks (Future x Positive, Neutral, Negative).

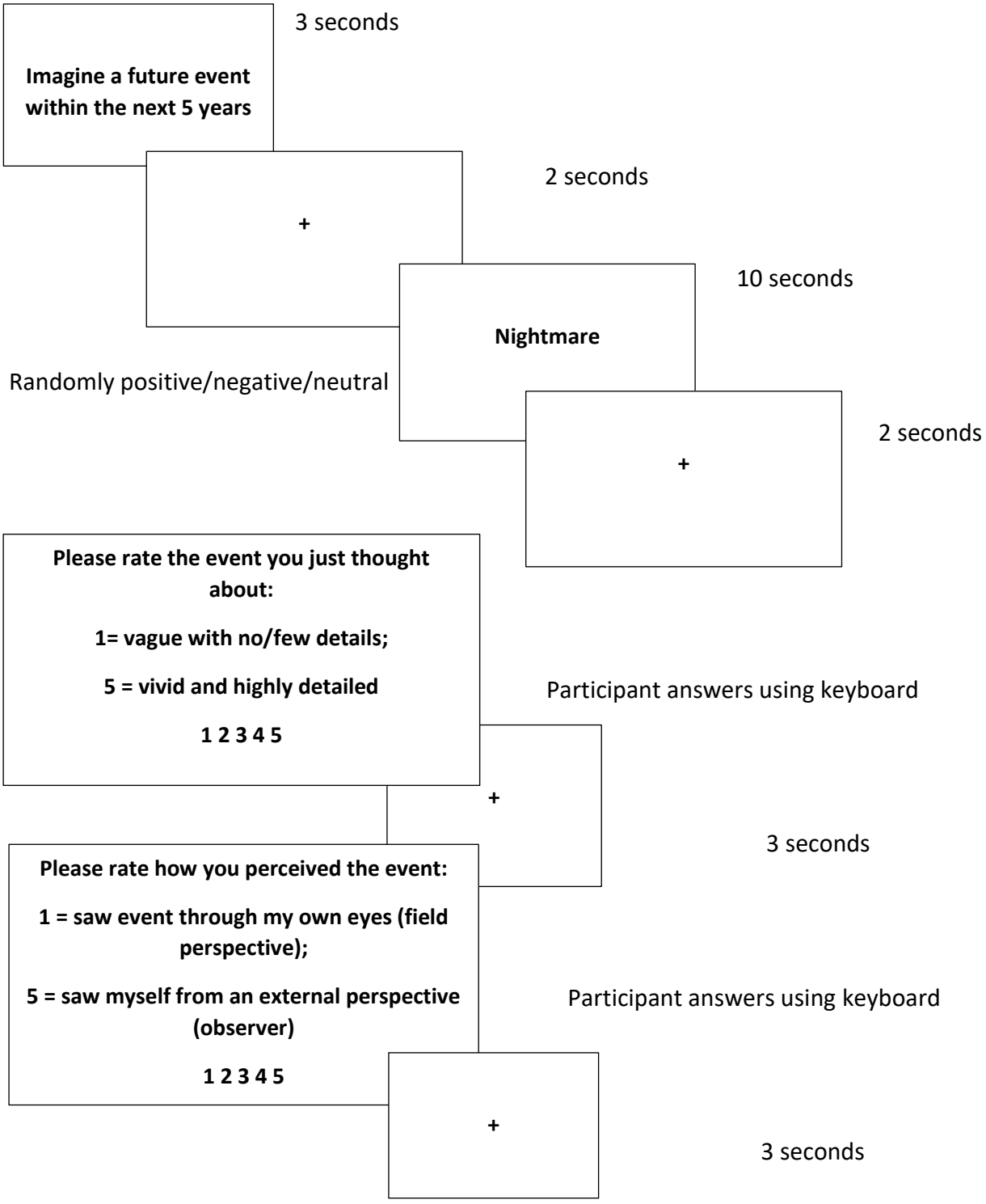


Fig. 4. – Diagram illustrating the screens that are displayed to participants throughout the experiment via E-Prime 2.0 software. This example demonstrates an "EFT-Negative" condition. Diagram to be interpreted in descending order.

EEG tasks:

1. Participants are presented with two tasks – "remember an event within the past 5 years: [cue word]"; and "imagine a future event within the next 5 years: [cue word]"
2. The valence of the cue word is randomly allocated to either positive, negative or neutral conditions, creating: "negative-future", "negative-past", "positive-past", "positive-future", "neutral-past" & "neutral-future" conditions.
3. Participants are given 10s to mentally construct the event (silently). Participants are then given 5s each to answer questions – between each question will be a 3 second fixation cross screen.
4. Participants are instructed to rate how realistic the event appeared to them based on: a.) amount of detail they retrieved or imagined (1 = vague with no/few details; 5 = vivid and highly detailed); b.) field or observer perspective (1 = saw event through my own eyes; 5 = saw myself from an external perspective)
5. Participants complete a total of 54 experimental trials (9 per valence-temporal condition). There will be a 3 second (fixation cross) screen between questions (above) and task presentation.
6. EEG will measure activity from 100ms before cue-word presentation to 1000ms after cue word presentation. Activity between 275-325ms (P300) and 775-825ms (LPC) windows will be analysed.
7. sLORETA images will be produced to visualise activity during P300 and LPC.

4.7. Within the current study, EFT-Positive data was not included in the analysis due to a technical error during the data collection sessions. Specifically, the data for EFT-Positive tasks was only recorded for a 1ms window instead of the intended 50ms window. Post-hoc examination of the e-Prime 2.0 script did not indicate any particular reason for such a recording error.

4.8. Participants' answers from both questions were combined and scored from 1-10 to create cognitive (episodic) measures for each temporal-valence condition and an EFT Total score. For example, a participant who rated a negative future event as 4 (vivid) and 2 (1st person field perspective) would receive an EFT-Negative score of 8/10 (as ratings for perspective are mirrored so that lower scores = more episodic).

Anxiety Group	EFT Total (SD)	EFT Positive (SD)	EFT Neutral (SD)	EFT Negative (SD)
High Anxiety	7.03 (0.94)	7.56 (1.13)	6.09 (0.86)	7.27 (1.9)
Low Anxiety	6.59 (0.44)	7.70 (0.43)	6.07 (1.36)	5.99 (0.68)

Table. 3. – Mean Episodic Future Thinking Scores for High Anxiety and Low Anxiety groups for each valence condition (Positive, Neutral, Negative) and a total Mean score (with standard deviations). Initial analysis shows small difference between groups on EFT Negative scores, and EFT Total scores. EFT-Negative scores were significantly positively correlated to GAD-7 scores, $r = .61$, $p < .01$.

4.9. Participants completing the EEG study followed the exact same procedure, but while wearing a dense-array Hydrocel 128-sensor EEG net (manufactured by EGI). EEG readings obtained from Netstation 5.4 software (EGI, 2016) were time-locked to 100ms before cue word presentation until 1000ms (1s) after cue word presentation. These were automatically categorised into 6 conditions: Imagine x Positive/Neutral/Negative and Remember x Positive/Neutral/Negative. After filtering the data (see below), topography for two time windows of interest – P300 (275-325ms) and LPC (775-825ms) – were visually examined across groups to examine apparent differences in activity.

Materials

4.10. The cognitive-only data was obtained both inside (N = 11) and outside (N = 5) of the EEG laboratory site and conditions. Participants who completed the experiment outside of the laboratory were all presented with the task using e-Prime 2.0 software run remotely on a laptop with a 13.3" screen.

EEG Laboratory Environment:

4.11. The EEG laboratory was equipped with EGI 128-channel HydroCel Geodesic Sensor Nets of different sizes connected to a wall-mounted NA400 amplifier. Dense geodesic array optimises accurate recording with the inclusion of eye-blink and eye-movement sensors, which allow for advanced filtering post-data collection (Catherwood, et al., 2014). Prior to positioning the net, the vertex point (Cz) was pre-marked on each participant's scalp in relation to the nasion, inion, and pre-auricular clefts (Catherwood, et al., 2014). Participants were all positioned in the same chair at the same angle – using tape marked on the floor to control for distance. Task presentation was completed using a standardised 4:3 LCD monitor positioned approximately 30-45cm away and at eye level – relevant to the participant. Participants were seated away from the researcher, with a room divider placed to minimise interference with concentration. The study was completed in silence, with the blinds drawn, and doors shut.

4.12. Participants were instructed (both verbally and in writing) to minimise all movements during the task – especially when presented with the cue word.

EEG Data Screening and Processing

4.13. EEG data was recorded using EGI Netstation 5.4 software and e-Prime 2.0 to co-ordinate and time-lock events (stimulus presentation was offset by 14ms). Prior to recording, impedance testing was conducted to ensure adequate connectivity and sensitivity across all 128 sensors. Input impedance for the Net Amps 400 amplifier is ≥ 1.0 kΩ and allows for scalp-electrode impedances of up to ≥ 200 kΩ (Ferree, Luu, Russell, & Tucker, 2001). Therefore, the scalp-electrode impedance was set for < 200 kΩ to ensure accurate signal acquisition.

4.14. Following this procedure, EEG grand average wave forms for High Anxiety and Low Anxiety groups were examined visually for indications of bad channels (excessive noise and possible eye blinks), and possible differences between groups. To do this, topographic maps were created for each condition. Time windows of interest were around the P300 wave (approximately 300ms after stimulus onset) and the LPC

(approximately 800ms after stimulus onset). Topographic maps were created to display mean voltage within 50ms windows. These were set at 275-325ms and 775-825ms after stimulus onset.

4.15. Examination of these visualisations indicate large differences between Anxiety Groups and small differences between valence condition (neutral and negative). Furthermore, there appear to be small differences between temporal window – 300ms vs 800ms. This could indicate sustained patterns of activation within the first second of episodic thought. See Fig. 5a and Fig. 5b (below) for topographic maps of each condition.

4.16. Initial interpretation suggests that areas of interest are the Left Temporal region, which appears significantly more active in High Anxiety participants. Frontal and Right Temporal regions appear differentially active across conditions. Posterior regions appear significantly less active in High Anxiety participants during both imagine (EFT) conditions. Low Anxiety participants appeared to display right hemispheric dominance in general across conditions, with more globalised activity in the Imagine-Negative condition specifically.

4.17. From this initial interpretation, regions of interest were mapped onto electrodes within those regions from the 128 sensors present, and a series of montages was created. As this study utilised a dense-array EEG net, the international 10-20 system was not suitable for localisation. Approximate equivolent sensor positions are available, however, they are not completely comparable to established EEG research that investigates ERPs across the international 10-20 sytem. Therefore, the sensors that are selected have been labelled for their approximate region and a tentative equivolent to the 10-20 system is listed below. The spatial resolution of dense-array EEG is superior than the traditional 10-20 system and the topographic maps below are overlaid with sensors (black dots). The sensors covering the regions of interest were selected to create the montage for statistics extraction of mean amplitude across two time windows.

Region of interest	Approximate 10-20 sensors
Left Temporal	T3, T5
Right Temporal	T4, T6
Frontal	F3, Fz, F4
Left Posterior	Pz, P3
Right Posterior	Pz, P4
Occipital	O1, O2

Table. 4. – Table showing regions of interest from the topographic maps presented below, and their approximate sensors in the International 10-20 system. This allows for tentative comparison between the result of this study and others established ERP research.

4.18. The analytical strategy used to investigate the data within the present study is outlined below. The richness of data obtained from dense-array EEG studies calls for robust statistical tests, such as parametric ANOVAs (used below), to control the risk of a Type 1 (false positive) error when comparing mean scores between independent samples (Field, 2009). Similar statistical analyses have been used in other (dense-array) EEG studies and also in fMRI studies investigating EFT, such as Mercuri et al. (2016) and Schacter, Benoit, De Brigard & Szpunar (2015). Therefore, results from statistical analyses within the present study are of comparable rigour to results from other neurophysiological studies of EFT. Furthermore, post-hoc tests from ANOVA and ANCOVA can produce estimates of effect size and power, which provides information on the size of any statistically significant difference between groups and whether the sample size was sufficient to find such an effect, should one exist (Field, 2009).

Results

Cognitive

4.19. Analyses for cognitive data focussed on investigating possible differences in EFT scores (Positive, Neutral, Negative) between Groups (High vs Low Anxiety). A two-way 2 (Anxiety Group: High or Low) x 3 (EFT-Valence Condition: Positive, Neutral or Negative) ANOVA was conducted.

4.20. Assumptions for normality were satisfied for all EFT conditions using the Shapiro-Wilks test, $p > .05$ (see Appendix E for Q-Q plots visually representing normality). Assumptions for homogeneity of variance were satisfied using Levene's test, $p > .05$. Therefore, the parametric tests used (ANOVA) were appropriate for EFT (cognitive) self-report data.

4.21. There was no statistically significant difference in EFT-Total scores between High Anxiety (*M = 7.02, SD = .94)* and Low Anxiety (*M = 6.56, SD = .44)* groups, $F (1, 14) = 1.15$, $p > .0.5$, $\eta p2 = .08$. There was no statistically significant difference in EFT-Positive scores between High Anxiety (*M = 7.56, SD = 1.13)* and Low Anxiety (*M = 7.70, SD = .43)* groups, $F (1, 14) = .08$, $p > .05$, $\eta p2 = .01$. There was no statistically significant difference in EFT-Neutral scores between High Anxiety (*M = 6.09, SD = .86)* and Low Anxiety (*M = 6.07, SD = 1.38)* groups, $F (1, 14) = .00$, $p > .05$, $\eta p2 = .00$. The score that most closely approached signifance between High Anxiety (*M = 7.27, SD = 1.99)* and Low Anxiety (*M = 5.99, SD = .68)* groups was EFT-Negative, $F (1, 14) = 2.24$, $p = .16$, $\eta p2 = .14$. Therefore, the null hypothesis was supported. There are no statistically significant differences in how participants across High Anxiety and Low Anxiety groups rate their Episodic Future Thinking.

EEG Anaylsis

The following processes were followed for the raw EEG data:

1.) Filtering: - First order highpass filter set at 0.3hz; lowpass filter set at 70hz; notch filter set at 50hz
2.) Segmentation: - segment lengths were time-locked to 100ms before stimulus onset to 1000ms (1s) after stimulus onset; offset was set at 14ms as per e-Prime 2.0 data.

Data was segmented into Imagine Pos; Imagine Neut; Imagine Neg and Remember Pos; Remember Neut; Remember Neg

3.) Artefact detection: - Eye blink detection was set at 140uv with a moving average of 80ms; eye movement detection was set to 55uv with a moving average of 80ms; and bad channel detection was set at 200uv across the entire segment with a moving average of 80ms. Channels were marked bad if these artefacts were detected for more than 20% of the segment. Segments were marked bad if a.) contained more than 10 bad channels, b.) contain an eye blink, or contains an eye movement.
4.) Manual Artefact Detection: - Part-filtered EEG data was analysed visually using Netstation Review software. Bad channels were inspected and marked for analysis, however, these fortunately appeared localised to a few channels near the eyes that had detected eye-blinks.
5.) Bad Channel Replacement: - A standardised Bad Channel Replacement tool was run on the data, which essentially replaces bad channels' data with averaged data from the surrounding electrode-channels. This inferred signal is therefore included in the final analysis, not the original bad channel signal.
6.) Averaging: - Good segments across subjects were averaged together to create an individual average for each participant.
7.) Baseline Correction: - Individual averages were run through a baseline correction procedure. Baseline was created for 100ms before segment and lasted 100ms (until 0s).
8.) Montage: - The files were run through a montage to collect average (baseline corrected) readings across all 128 sensors.
9.) Grand Averaging: - Files for individual participants were run through a grand averaging procedure to collate data from all participants into "High Anxiety" and "Low Anxiety" average files.

4.22. Analysis for EEG waveform data focussed on two time windows, one covering the approximate P300 (275-325ms after stimulus onset) and another covering the approximate LPC (775-825ms). The analysis was broken down into microvoltage averaged across sensors in the Regions of Interest (ROI): Left Temporal (T3, T5), Frontal (F3, Fz, F4), Right Temporal (T4, T6), Occipital (O1, O2), Left Posterior (P3), Right Posterior (P4) regions.

4.23. Assumptions of normality of distribution were satisfied for each ROI variable apart from Left Temporal, which was found to be significant using a Shapiro-Wilks test, $p < .05$. Assumptions for homogeneity of variance were satisfied for all ROI variables using Levene's test, $p > .05$. Therefore, results from parametric tests (ANOVA) below should be treated with caution when considering the Left Temporal ROI.

275-325ms (P300)

4.24. A 2 (Anxiety group) x 6 (ROI) ANOVA was conducted to investigate the effect of Anxiety Group (High vs Low) on mean potentials at six Regions of Interest – ROI (Left Temporal, Prefrontal, Right Temporal, Occipital, Left Posterior, Right Posterior) during

EFT, approximately 300ms after stimulus onset. A statistically significant effect of Anxiety Group was found for mean amplitude in Left Temporal regions, F (1, 2) = 76990.18, p < .001, ηp2 = 1; Frontal regions, F (1, 2) = 234.67, p < .005, ηp2 = .99; and Left Posterior regions, F (1, 2) = 60.87, p < .05, ηp2 = .97. There was no significant effect of Anxiety Group on Right Temporal regions, F (1, 2) = .82, p > .05, ηp2 = .29; Occipital regions, F (1, 2) = .74, p > .05, ηp2 = .27; or Right Posterior regions, F (1, 2) = 1.57, p > .05, ηp2 = .44. The results indicate that High Anxiety participants demostrated significantly higher positive mean potential at Left Temporal and Left Posterior regions; and significantly negative mean potentials at Frontal regions 275-325ms after cue word onset during EFT tasks (see Table. 5 below).

ROI	High Anxiety Mean (SD)	Low Anxiety Mean (SD)
Left Temporal (T3, T5)	29.58 (0.29)	-31.40 (0.10)
Right Temporal (T4, T6)	10.44 (1.69)	11.59 (0.64)
Frontal (F3, Fz, F4)	0.31 (0.89)	31.73 (2.76)
Occipital (O1, O2)	-17.42 (1.15)	-21.65 (6.83)
Left Posterior (Pz, P3)	6.78 (1.15)	-19.05 (4.54)
Right Posterior (Pz, P4)	5.20 (1.97)	0.31 (5.02)

Table 5. – Comparison of mean amplitudes (with standard deviations) for Regions of Interest (ROIs) during the P300 (275-325ms) window across Episodic Future Thinking tasks.

4.25. The assumption for independence of the covariate was satisfied using an independent samples t-test. There was no significant difference in Neutral Valence between High Anxiety (*M = 6.09, SD = .86)* and Low Anxiety (*M = 6.07, SD = 1.38)* groups; *t (14) = .04, p > .05.* There was no significant difference in Negative Valence between High Anxiety (*M = 2.28, SD = .92)* and Low Anxiety (*M = 2.30, SD = .84)* groups; *t (14) = .02, p > .05.* The assumption for homogeneity of regression slopes was satisfied using ANOVA. There was a statistically significant interaction effect of Valence and Anxiety group on mean amplitude during P300 at ROIs, *p < .05.* Therefore, the parametric test (ANCOVA) completed below was appropriate.

4.26. An ANCOVA was conducted to investigate this effect further, while controlling for the effect of Valence (Neutral vs Negative). The effect of Anxiety Group on mean potentials during EFT remained significant for Left Temporal regions, F (2, 3) = 104883.23 , p < .005, ηp2 = 1; and Frontal regions, F (2, 3) = 286.49, p < .05, ηp2 = .99. However, Left Posterior regions were no longer significant, p > .05.

775-825ms (LPC)

4.27. A 2 (Anxiety Group) x 6 (ROI) ANOVA was conducted to investigate the effect of Anxiety Group (High vs Low) on mean potentials at six Regions of Interest – ROI (Left Temporal, Prefrontal, Right Temporal, Occipital, Left Posterior, Right Posterior) during

EFT, approximately 800ms after stimulus onset. A statistically significant effect of Anxiety Group was found for Left Temporal regions, F (1, 3) = 8130.26, p < .001, ηp2 = 1; Frontal regions, F (1, 3) = 1356, p < .005, ηp2 = 99; Occipital regions, F (1, 3) = 79.75, p < .05, ηp2 = .94; Left Posterior regions, F (1, 3) = 257.03, p < .005, ηp2 = .99; and Right Posterior regions, F (1, 3) = 120.70, p < .01, ηp2 = .97. There was no statistically significant effect of Anxiety Group on Right Temporal regions, F (1, 2) = 1.59, p > .05, ηp2 = .44. The results indicate that High Anxiety participants demostrated significantly higher mean positive potential at Left Temporal and Left Posterior regions; and significantly negative mean potentials at Frontal, Occipital and Right Posterior regions 775-825ms after cue word onset during EFT.

4.28. The assumption for independence of the covariate was satisfied using an independent samples t-test. There was no significant difference in Neutral Valence between High Anxiety (*M = 6.09, SD = .86)* and Low Anxiety (*M = 6.07, SD = 1.38)* groups; *t (14) = .04, p > .05.* There was no significant difference in Negative Valence between High Anxiety (*M = 2.28, SD = .92)* and Low Anxiety (*M = 2.30, SD = .84)* groups; *t (14) = .02, p > .05.* The assumption for homogeneity of regression slopes was satisfied using ANOVA. There was a statistically significant interaction effect of Valence and Anxiety group on mean amplitude during LPC at ROIs, *p < .05.* Therefore, the parametric test (ANCOVA) completed below was appropriate.

ROI	High Anxiety Mean (SD)	Low Anxiety Mean (SD)
Left Temporal (T3, T5)	30.68 (0.61)	-23.89 (0.60)
Right Temporal (T4, T6)	10.22 (0.49)	10.68 (0.12)
Frontal (F3, Fz, F4)	-0.41 (0.14)	21.99 (0.85)
Occipital (O1, O2)	-15.99 (0.36)	-7.06 (1.85)
Left Posterior (Pz, P3)	8.65 (0.29)	-5.46 (1.21)
Right Posterior (Pz, P4)	3.35 (0.23)	9.49 (0.76)

Table 6. – Comparison of mean amplitudes (with standard deviations) for Regions of Interest (ROIs) during the LPC (775-825ms) window across Episodic Future Thinking tasks.

4.29. An ANCOVA was conducted to investigate this effect further, while controlling for the effect of Valence (Neutral vs Negative). The effect of Anxiety Group during EFT remained significant at Left Temporal regions, F (2, 3) = 2032.57, p < .05, ηp2 = 1; Frontal regions, F (2, 3) = 1008.74, p < .05, ηp2 = 1; and Left Posterior regions, F (2, 3) = 240.81, p < .05, ηp2 = .99. However, Occipital regions were no longer significant, F (2, 3) = 41.1, p > .05, ηp2 = .99.

Summary

4.30. Analyses of mean amplitudes at the six ROIs revealed significant differences between groups, while controlling for the effect of valence. These results have been consolidated into a summary table (Table 4 - below).

ROI	P300	Mean Difference (SE)	Observed Power	LPC	Mean Difference (SE)	Observed Power
Left Temporal (T3, T5)	Positive **	60.98 (.13)	1.00	Positive *	54.58 (.86)	1.00
Right Temporal (T4, T6)	Positive – n.s.	-1.16 (.74)	.10	Positive – n.s.	-.46 (.44)	.75
Frontal (F3, Fz, F4)	Negative *	-31.42 (1.32)	.94	Negative *	-22.40 (.50)	1.00
Occipital (O1, O2)	Negative – n.s.	4.23 (4.02)	.08	Negative – n.s.	-8.93 (1.05)	.50
Left Posterior (Pz, P3)	Positive – n.s.	25.83 (2.39)	.60	Positive *	14.11 (.65)	.91
Right Posterior (Pz, P4)	Positive – n.s.	4.79 (2.16)	.14	Positive – n.s.	-6.14 (.38)	.80

*Table 7. – Key results from ANCOVAs controlling for variance of Valence (Neutral vs Negative) for High Anxiety group at both time windows: P300 (275-325ms) and LPC (775-825ms). Key: p < .005**; p < .05*; n.s. = not significant; Mean Difference (SE) = High Anxiety – Low Anxiety with Standard Error; Positive = positive mean potentials at ROI compared to baseline; Negative = negative mean potentials at ROI compared to baseline.*

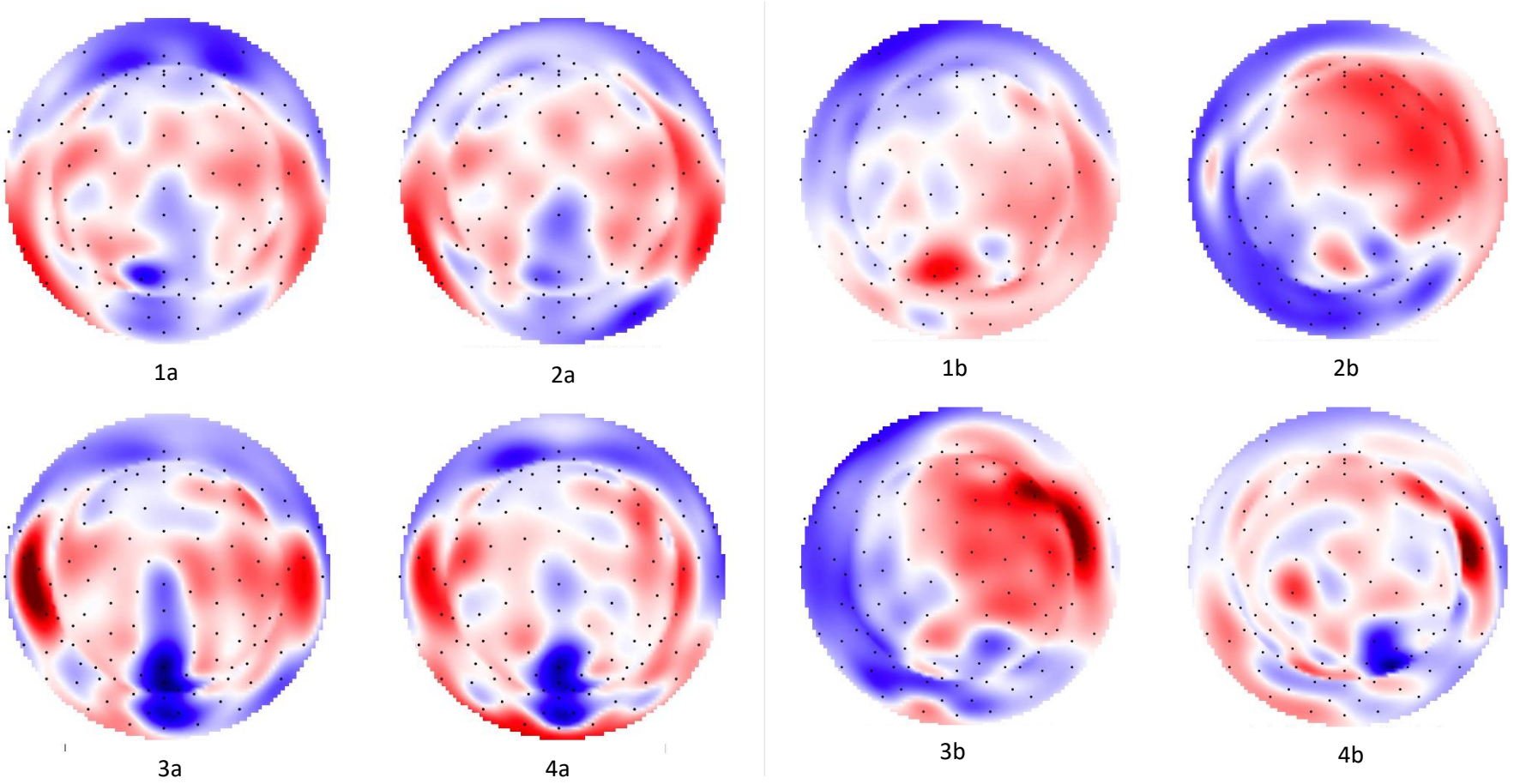
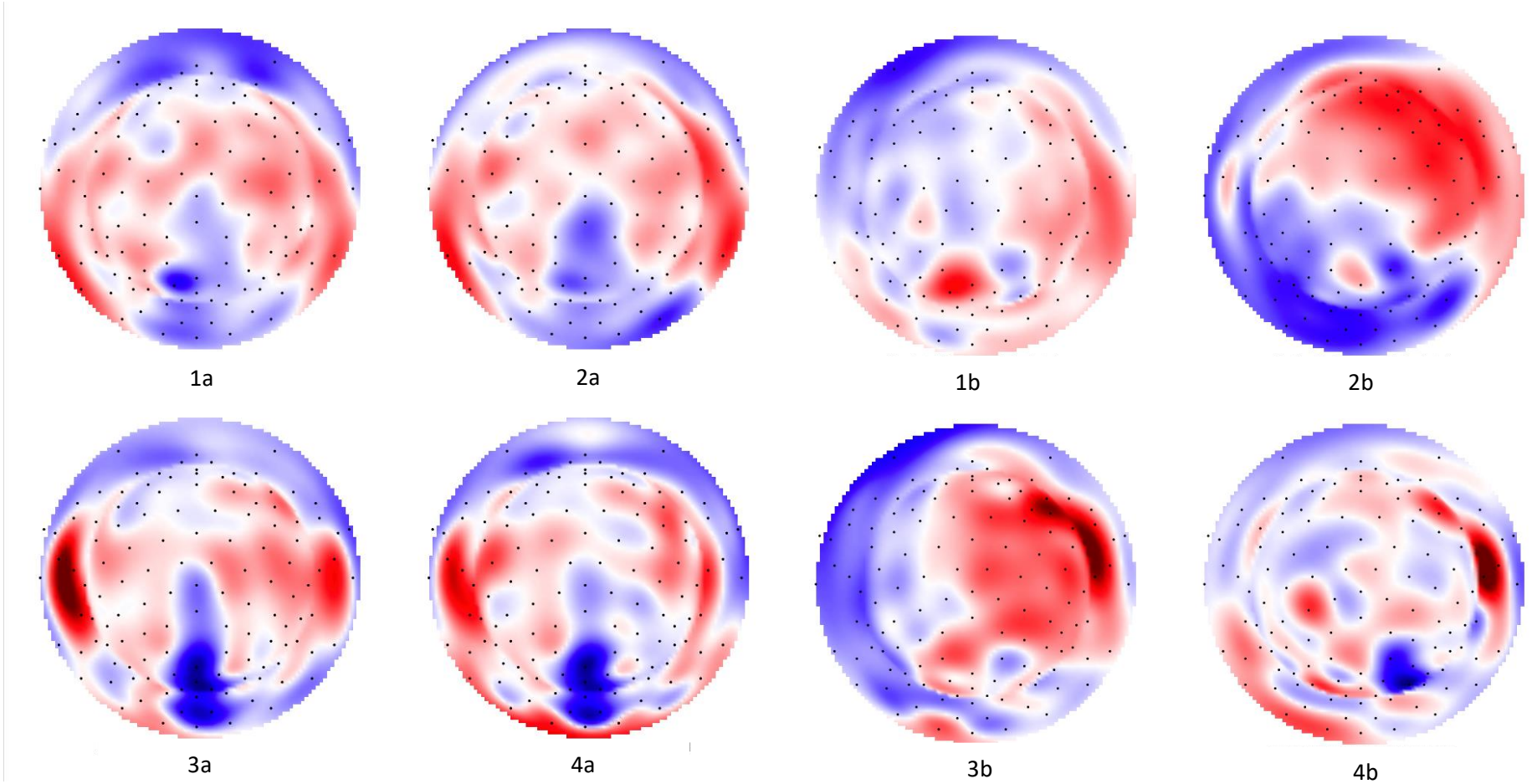


Fig. 5a – Topographic maps for P300 (275-325ms after stimulus onset). The left four maps are for the High Anxiety group, while the right four maps are for the Low Anxiety group. Condition is in order of Remember Neutral (1a/1b), Remember Negative (2a/2b), Imagine Neutral (3a/3b), Imagine Negative (4a/4b). Spectrum goes from Dark Blue = negative potential compared to baseline; Dark Red = positive potential compared to baseline; White = no potential differences. Black dots are the 128 sensors from the dense-array EEG net.



High Anxiety (800ms) vs. Low Anxiety (800ms)

Fig. 5b – Topographic maps for LPC (775-825ms after stimulus onset). The left four maps are for the High Anxiety group, while the right four maps are for the Low Anxiety group. Condition is in order of Remember Neutral (1a/1b), Remember Negative (2a/2b), Imagine Neutral (3a/3b), Imagine Negative (4a/4b). Spectrum goes from Dark Blue = negative potential compared to baseline; Dark Red = positive potential compared to baseline; White = no potential differences. Black dots are the 128 sensors from the dense-array EEG net.

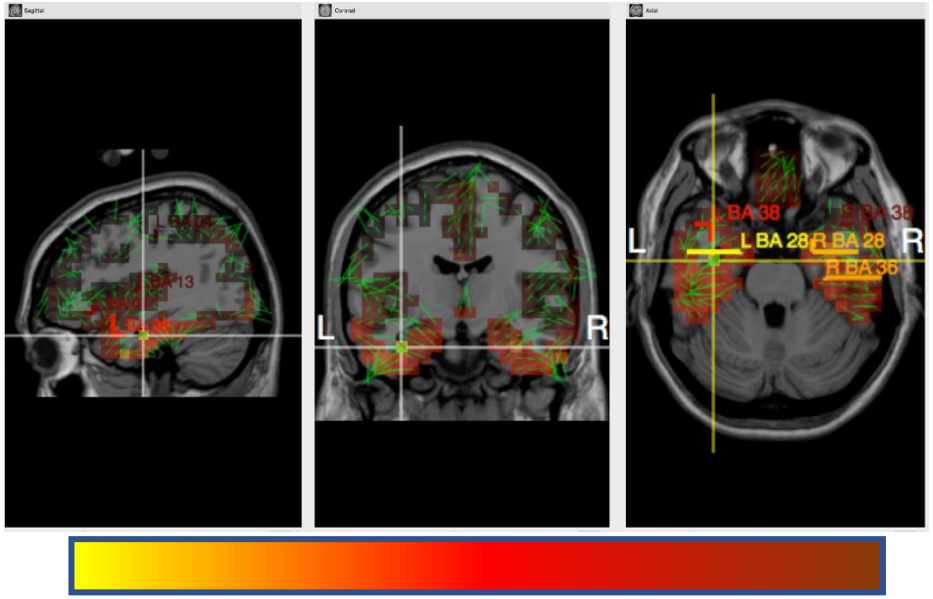
Source Estimation Analysis – sLORETA

4.31. While the above analyses indicated a statistically significant differences in mean amplitude between groups at the Left Temporal, Left Posterior and Frontal electrode sites, this is limited by low spatial resolution. Further analyses revealed the approximate source locations of the differences found above. To help visualise these sources, sLORETA was conducted and images are displayed below (see figures 5a-d).

4.32. Upon initial visual inspection, apparent differences in localisation of peak amplitudes emerge between High and Low Anxiety groups, and between Neutral and Negative Valence conditions. There was little difference in either group between source potentials at 300ms and 800ms time windows. Therefore, images presented are selected for the 800ms time window, as this was hypothesised to reflect more elaboration than the initial (300ms) early period of processing (see Chapter THREE for discussion). The sLORETA images presented below have been selected because they effectively demonstrate localised peak activity and allow for easy comparison.

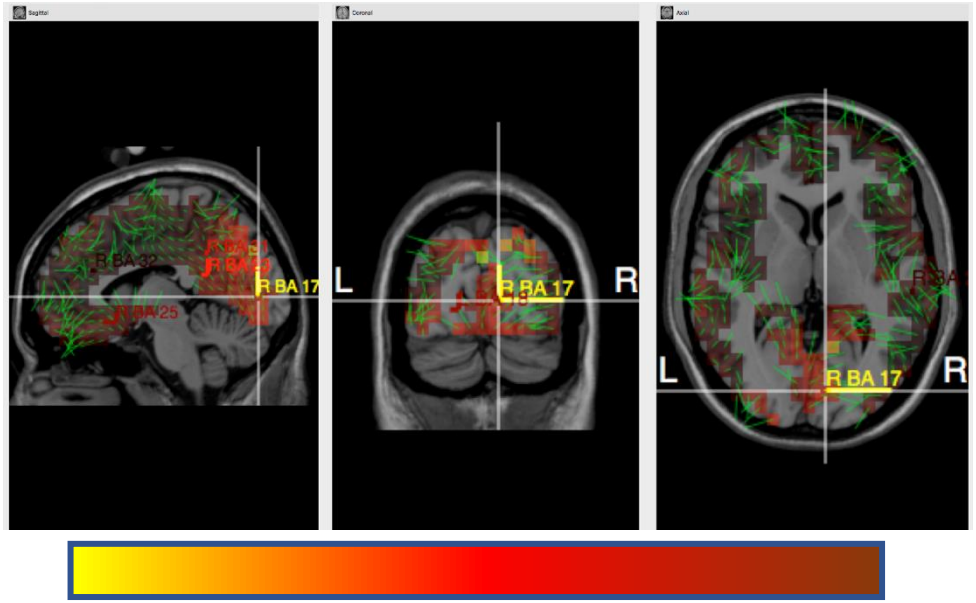
	EFT Neutral	EFT Negative
High Anxiety	• Left hemispheric dominance • Peak amplitude in Medial Temporal Lobe; Superior Frontal Cortex; Hippocampus and Amygdala	• Peak amplitude in Occipital Lobe; Posterior Cingulate Cortex; Medial Temporal Lobe; and Amygdala. • Marked by positive potential at Occipital Lobe – visual cortex – and PCC compared to Neutral
Low Anxiety	• Peak amplitude in Medial Temporal Lobe; Amygdala; Superior Frontal Cortex; and Middle Frontal Gyrus. • Similar to High Anxiety EFT Neutral, except for Middle Frontal Gyrus activity	• Right hemispheric dominance • Peak amplitude in Superior Temporal Gyrus; Medial Temporal Lobe; Amygdala; Inferior Frontal Gyrus; and (left) Subcollosal Area. • Marked by increase in right frontal activation in the Inferior Frontal Gyrus.

Table. 5. – Key findings from visual analysis of sLORETA images indicating peak intensity for High Anxiety and Low Anxiety groups, at approximately 800ms (775-825ms) after stimulus onset for both Neutral and Negative (valence) EFT tasks. These represent the approxiate LPC ERP activity.



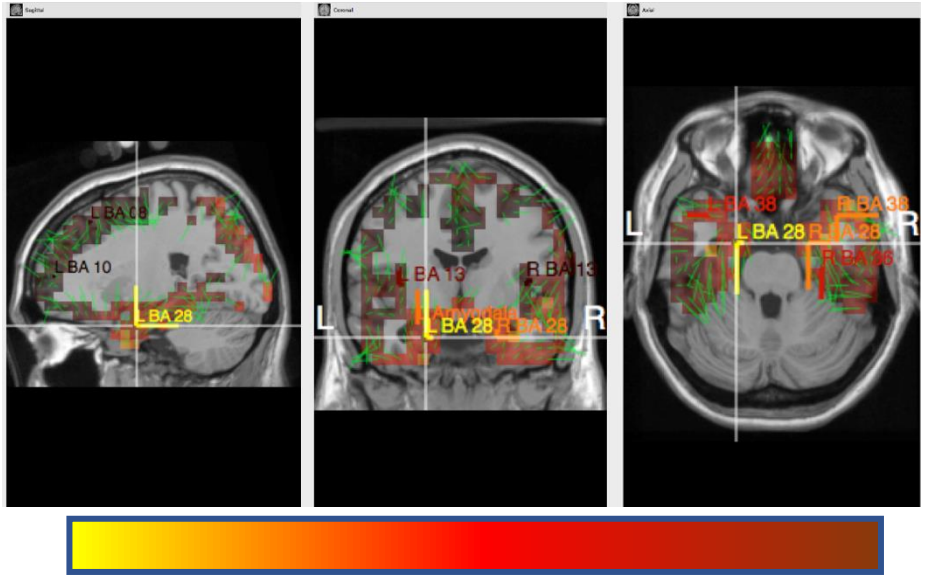
Maximum (60.65) *Minimum (4.66)*

Fig. 6a: - sLORETA images (Sagittal – Coronal – Axial; from left to right) for High Anxiety group during EFT-Neutral tasks at approximately 800ms (775-825ms) after cue word (stimulus) onset. Peak amplitude is located in (Left) Brodmann Areas (BAs) 28, 35, 20 and 36. Together, these BAs are localised to the Inferior Temporal Gyrus and Perirhinal Cortex of the Medial Temporal Lobe. Further peak activity was found in the Temporopolar area of the Superior Temporal Gyrus (BA38); left and right Hippocampus; and Amygdala. Activity reflects the recruitment of the Episodic Core Network, with slight left hemispheric dominance but general lateralisation of potentials. (Right) frontal and prefrontal areas were visually weaker (less active) than others.



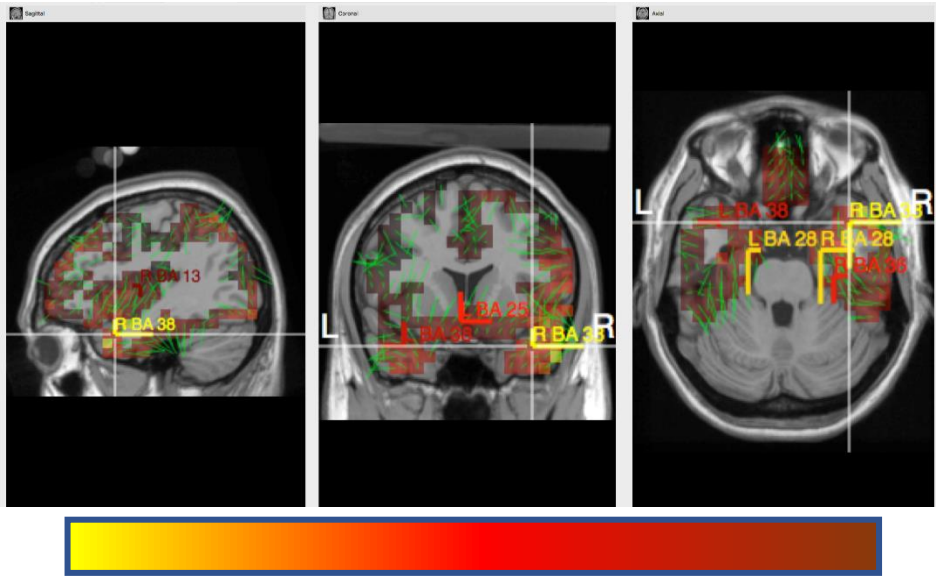
Maximum (73.52) *Minimum (4.23)*

Fig. 6b:- sLORETA images (Sagittal – Coronal – Axial; from left to right) for High Anxiety group during EFT-Negative tasks at approximately 800ms (775-825ms) after cue word (stimulus) onset. Peak amplitude is localised to Brodmann Areas (BAs) BA17 (Lingual Gyrus) and BA18 (Lateral Occipital Gyrus) of the Occipital Lobe. Further peak activation is seen throughout the Posterior Cingulate Cortex (BA23 and BA30); Medial Temporal Lobe (BA 28, 20, 35, 36); and Amygdala. Peak activity in the visual areas (Occipital Lobe) and Posterior Cingulate Cortex is markedly higher than in EFT-Neutral condition.



Maximum (62.38) *Minimum (5.12)*

Fig. 6c:- sLORETA images (Sagittal – Coronal – Axial; from left to right) for Low Anxiety group during EFT-Neutral tasks at approximately 800ms (775-825ms) after cue word (stimulus) onset. Peak amplitude is localised to the Medial Temporal Lobe (BA 28, 35 and 36); (right) Amygdala; Temporopolar area of the Superior Temporal Gyrus (BA38); and Middle Frontal Gyrus (BA10 and 44). Localised peak amplitudes appear similar to EFT-Neutral tasks in the High Anxiety group, with the exception of increased activation within the Middle Frontal Gyrus.



Maximum (79.35) *Minimum (4.74)*

Fig. 6d:- sLORETA images (Sagittal – Coronal – Axial; from left to right) for Low Anxiety group during EFT-Negative tasks at approximately 800ms (775-825ms) after cue word (stimulus) onset. Peak amplitude is localised to the (right) Superior Temporal Gyrus (BA 38); Medial Temporal Lobe (BA 28, 34, 35 and 36); Amygdala; Inferior Frontal Gyrus (BA 44, 45 and 47); and (Left) Subcollosal area (BA 25). Localised peak amplitudes appear similar to the EFT-Neutral tasks in Low Anxiety, with the exception of increased right frontal activation within the Inferior Frontal Gyrus.

sloreta Analyses

4.33. Assumptions for normality of distribution were satisfied using Shapiro-Wilks test for normality and Levene's test for homogeneity of variance. No significant results were found for BAs across P300 or LPC conditions. Therefore, it was appropriate to complete the parametric tests (ANOVA) reported below.

P300 (275-325ms)

4.34. An ANOVA was conducted to investigate the effect of Anxiety Group (High vs Low) on mean recruitment of neural regions (Brodmann Areas – BAs) comprising the Episodic Core Network (as estimated by sLORETA) during EFT tasks. A statistically significant effect of Anxiety Group (High vs Low) was found for the Left BA 09, $F(1, 3) = 16.75$, $p < .05$, $\eta p2 = .85$; Left BA 23, $F(1, 3) = 16.98$, $p < .05$, $\eta p2 = .85$; Left BA 28, $F(1, 3) = 10.9$, $p < .05$, $\eta p2 = .78$; Left BA 35, $F(1, 3) = 18.22$, $p < .05$, $\eta p2 = .86$; and Left BA 36, $F(1, 3) = 11.68$, $p < .05$, $\eta p2 = .8$. These regions of the Episodic Core Network were recruited significantly more in High Anxiety participants than Asymptomatic Controls during EFT tasks.

BA (Gyri)	High Anxiety *M (SD)*	Low Anxiety *M (SD)*	F	Sig.	ηp2	Observed Power
LBA09 (mPFC)*	12.24 (0.48)	9.77 (0.66)	16.749	.026	.848	.772
LBA23 (PCC)*	27.35 (0.28)	26.03 (0.39)	16.977	.026	.850	.777
LBA28 (MTL)*	59.26 (1.52)	57.03 (1.59)	10.901	.046	.784	.606
LBA35 (MTL)*	73.90 (3.97)	72.39 (3.71)	18.222	.024	.859	.802
LBA36 (MTL)*	72.15 (2.72)	69.91 (2.53)	11.678	.042	.796	.633

*Table. 6. - Summary Table (ANOVA results) of Brodmann Areas (BAs) found to be recruited significantly differently between groups (High Anxiety vs Low Anxiety) between 275-325ms after stimulus onset, during EFT tasks. Areas activated in the left hemisphere are highlighted in orange; areas activated in the right hemisphere are highlighted in grey. * = p < .05.*

LPC (775-825ms)

4.35. An ANOVA was conducted to investigate the effect of Anxiety Group (High vs Low) on mean recruitment of neural regions (Brodmann Areas – BAs) comprising the Episodic Core Network (as estimated by sLORETA) during EFT tasks. A statistically significant effect of Anxiety Group was found for the Right BA 08, $F(1, 3) = 16.96$, $p < .05$, $\eta p2 = .92$; Left BA 09, $F(1, 3) = 16.96$, $p < .05$, $\eta p2 = .92$; Left BA 09, $F(1, 3) = 23.55$, $p < .05$, $\eta p2 = .94$; Right BA 09, $F(1, 3) = 13.37$, $p < .05$, $\eta p2 = .9$; Right BA 11, $F(1, 3) = 21.07$, $p < .05$, $\eta p2 = .93$; Left BA 21, $F(1, 3) = 31.08$, $p < .05$, $\eta p2 = .95$; Left BA 24, $F(1, 3) = 101.56$, $p <$

.005, ηp2 = .99; Right BA 24, F (1, 3) = 310.79, p < .001, ηp2 = 1; Left BA 35, F (1, 3) = 13.36, p < .05, ηp2 = .9; and Left BA 36, F (1, 3) = 21.7, p < .05, ηp2 = .94. These regions of the Episodic Core Network were recruited significantly more in High Anxiety participants than Asymptomatic Controls during EFT tasks.

BA (Gyri)	High Anxiety *M (SD)*	Low Anxiety *M (SD)*	F	Sig.	ηp2	Observed Power
RBA08 (PFC)*	10.59 (1.86)	9.11 (1.63)	16.964	.023	.919	.831
LBA09 (mPFC)*	10.39 (2.19)	9.02 (1.89)	23.553	.015	.940	.922
RBA09 (mPFC)*	7.01 (0.11)	6.05 (0.11)	13.373	.032	.899	.745
RBA11 (PFC)*	16.20 (2.21)	15.39 (1.66)	21.072	.017	.934	.896
LBA21 (Lateral Temporal)*	13.02 (0.95)	12.29 (0.81)	31.076	.010	.954	.969
LBA24 (mPFC)**	9.75 (1.87)	8.31 (1.74)	101.562	.002	.985	1.000
RBA24 (mPFC)**	7.83 (1.70)	6.07 (1.62)	310.791	.000	.995	1.000
LBA35 (MTL)*	69.56 (1.78)	65.49 (1.02)	13.357	.032	.899	.744
LBA36 (MTL)*	68.43 (2.98)	64.63 (1.11)	21.695	.016	.935	.903

*Table. 7. - Summary Table (ANOVA results) of Brodmann Areas (BAs) found to be recruited significantly differently between groups (High Anxiety vs Low Anxiety) between 775-825ms after stimulus onset, during EFT tasks. Areas activated in the left hemisphere are highlighted in orange; areas activated in the right hemisphere are highlighted in grey. * = p < .05; ** = p < .005.*

Negative Episodic Future Thinking – LPC (775-825ms)

4.36. An ANOVA was conducted to investigate the effect of Anxiety Group (High vs Low) on mean recruitment of neural regions (Brodmann Areas – BAs) comprising the Episodic Core Network (as estimated by sLORETA) during Negative EFT tasks. A statistically significant effect of Anxiety Group was found for the Right BA 13, F (1, 4) = 23.2, p < .05, ηp2 = .92; and Right BA 21, F (1, 4) = 306.15; p < .05, ηp2 = .69.

BA (Gyri)	High Anxiety *M (SD)*	Low Anxiety *M (SD)*	High Anxiety – Low Anxiety Mean Difference (SE)	Observed Power
RBA13 (Insular Cortex)	13.40 (.65)	11.32 (.86)	2.08 (.43)	.69
RBA21 (Middle Temporal Gyrus)	30.20 (.35)	29.78 (.21)	.42 (.26)	.20

Table. 8. – Post-hoc test results from ANOVA displaying Mean Difference (Standard Error) of intensity from sLORETA at RBA 13 and RBA 21 during LPC; and Observed Power.

Source Estimation Summary

4.37. sLORETA findings (both visually and statistically) indicate that the Episodic Core Network is differentially activated between groups within both 50ms time windows. High Anxiety participants recruited the Left MTL, mPFC and prefrontal regions more than Asymtomatic Controls. ANOVA findings indicate statistically significant differences between Anxiety Groups in recruitment of the Right BA 13 (Insular Cortex) and Right BA 21 (Middle Temporal Gyrus) regions during Negative Episodic Future Thinking tasks. Specifically, High Anxiety participants recruit these regions significantly more than Low Anxiety participants during Negative EFT.

Results Summary

4.38. There was no statistically significant difference in participants' ratings of episodic detail between High Anxiety and Low Anxiety groups for any EFT-Valence condition.

4.39. The results indicate that High Anxiety participants demostrated significantly higher positive mean potential at Left Temporal and Left Posterior regions; and significantly negative mean potentials at Frontal regions 275-325ms after cue word onset (P300) during EFT tasks. High Anxiety participants demostrated significantly higher mean positive potential at Left Temporal and Left Posterior regions; and significantly negative mean potentials at Frontal, Occipital and Right Posterior regions 775-825ms after cue word onset (LPC) during EFT.

4.40. Analyses of sLORETA results at P300 indicate that High Anxiety participants demonstrated significantly higher recruitment of LBA09 (mPFC), LBA23 (PCC), LBA28, LBA35 and LBA36 (MTL) regions during EFT. Analysis of sLORETA results at LPC indicate that High Anxiety participants demonstrated significantly higher recruitment of RBA08 (PFC), LBA09 and RBA09 (mPFC), RBA11 (PFC), LBA21 (Lateral Temporal), LBA24 and RBA24 (mPFC), LBA35 and LBA36 (MTL) regions during EFT.

4.41. Analyses of sLORETA results at LPC indicate that High Anxiety participants demonstrated significantly higher recruitment of RBA13 (Insular Cortex) and RBA23 (Middle Temporal Gyrus) during negative EFT.

Hypotheses:

1.) There will be a significant difference between High Anxiety and Asymptomatic Control groups' self-report ratings of Episodic Future Thinking (**Reject**)
2.) There will be significant neurophysiological differences (as measured by EEG) between High Anxiety and Asymptomatic Control groups (**Accept**)
3.) There will be significant differences between groups in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Episodic Future Thinking (**Accept**)
    a. There will be significant differences between groups in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Negative Episodic Future Thinking (**Accept**)

5.0. Chapter FIVE – Discussion

This chapter aims to critically discuss each of the key findings from the analyses performed and reported above in Chapter FOUR in relation to each of the experimental hypotheses. These findings will be reviewed with consideration of a wide range of relevant empirical literature on anxiety disorders and EFT. Recommendations are also made for potential future investigations of EFT in anxious populations. Following this discussion, a summary of the project and conclusion from the key findings is presented.

Cognitive Findings

Hypothesis 1: *There will be a significant difference between High Anxiety and Asymptomatic Control groups' self-report ratings of Episodic Future Thinking (**Reject**)*

5.1 Firstly, analysis of the cognitive data (measure of EFT) obtained within the present study found no significant differences between groups (High vs Low Anxiety) and no significant interaction between Anxiety Group and Valence condition. However, this information was somewhat secondary within the project as there already exists a range of information available regarding cognitive differences during EFT and EM for anxiety disorders at the clinical level (Miloyan, Pachana & Suddendorf, 2014). The general findings from studies such as Miloyan, Pachana & Suddendorf (2014) is that anxious participants produce more negative (but not less positive) prospections and memories than healthy controls. For the purpose of this analysis, the only conclusion that can be drawn is that High Anxiety participants did not produce significantly *more episodic* prospections than Low Anxiety participants, in any valence condition, based on the results of the novel measure used. However, this also raises methodological issues with the self-report questions that measured episodic vs semantic details. This was a novel, brief (two questions; 5-point Likert scales) measure that has not been replicated or utilised in other research before. Therefore, there are no current indications of its psychometric appropriateness or validity within this project. It was used as a proxy measure to obtain self-report data on two factors of episodicity – vividness and perspective. The reason such a measure was utilised in place of traditional and reliable measures, such as the adapted-AI (Addis & Schacter, 2008) is due to time contraints that are unique to EEG data collection. Specifically, the dense-array EEG hydrocel nets utilised within the present study rely on an electrolite solution that increases skin conductance, improving accuracy of readings obtained from the scalp. However, these sensors begin to dry out after approximately 30 minutes (EGI, 2017), resulting in a significant deterioration in the quality of data obtained. Tried and tested measures of EFT and EM such as the adapted-AI require timely administration, which would not be compatible with the current study. The present study kept the EEG data collection to below 30 minutes per participant, to maintain a high level of accuracy for EEG data. However, it is noted that these measures (or similarly time-consuming measures) have been utilised within fMRI research, which is not limited by such a practical time-constraint. Retrospective methodological critique of the present study may call for novel uses of EFT measures such as the adapted-AI. For example, one such design may involve completing the adapted-AI immediately after the EEG tasks. This could involve the same

cue words for easy comparison. However, this may cause distortions between memory and prospection as the participant would essentially be *remembering* their previous *prospection* from the EEG task. Therefore, it would be significantly unclear whether participants' EEG recordings were reflective of the level of episodic detail (obtained later by adapted-AI) they generated during the EEG tasks.

5.2 Alternative stimuli could also yield more ecological validity for the phenomenon of EFT. For example, while the present study utilised ANEW (Bradley & Lang, 1994) for standardised affective stimuli, future research could utilise alternative affective stimuli. The vagueness of presenting a single cue word may not be as useful in generating episodic memories or prospections compared with a small prose text (such as ANET; Bradley & Lang, 2007), or pictorial affective stimuli (IAPS; Lang et al., 2008) or aurally (IADS; Bradley & Lang, 2007). For example, Altgassen, Kretschmer & Schnitzspahn (2017) demonstrated the significantly positive effect increased context and purposeful cue instructions had on generating more episodic details across adolescents and young adults. This suggests that by improving the specificity and personal purpose (goal-directed) of the EFT task, the individual is more able to generate episodic prospections. Future research should similarly investigate whether the mode of affective stimuli significantly effects the level of episodic details produced during EFT or EM.

5.3 D'Argembeau & Mathy (2011) utilised more personally relevant cues for participants and found a significant difference in the level of episodic details produced depending on the type of cue. For example, cues relating to personal life goals (e.g. "to have a job I like" or "to have children") resulted in the most episodic details, compared with people- or location-based cues. Therefore, personal cue words could be generated in future research and categorised accordingly. Participants could be instructed to complete the adapted-AI and generate prospections that are positive, negative and neutral *to them,* prior to the EEG task (separate data collection session), and then suggest a cue word or phrase that corresponds to their most episodic prospections for use within the EEG task. However, this presents similar issues to the above suggestions – these prospections would be subject to distortion during the EEG task and not clearly prospections at all. This would risk the data collected reflecting neurophysiological activity related to EM – not EFT – which would be difficult to distinguish because of the significant neural overlap during EM and EFT. These projected difficulties highlight the meta-cognitive nature of EFT as a discrete human faculty, and demonstrate compatability issues with EEG research compared to fMRI research. Future research into EFT differences based on trait anxiety may be better suited to fMRI neuroimaging methods. It allows for better spatial resolution compared to sLORETA EEG techniques; it has been utilised within a range of other EFT research and therefore may allow for better comparison between findings; and it allows for more accurate but time-consuming measures of EFT (such as adapted-AI) compared to EEG.

5.4 Regardless of the measure of EFT utilised, it is the qualitative content of negative future thoughts that is significant and typical of anxiety disorders – the negative threat-bias (Ellis & Hudson, 2010; Hirsch & Matthews, 2012; Goodwin, Yiend & Hirsch, 2017). No measures of EFT to date – to the best of the researcher's knowledge – incorporate ratings of subjective meta-cognitive threat, fear or anxiety related to the prospection

itself. Indeed, even the standardised ratings from the Self-Assessment Manikin – SAM (Lang, 1980) – would only yield ratings of valence (positive – negative), arousal (low – high) and dominance (in control – controlled/dominated). Of these three affective dimensions, dominance would be the most relevant as a proxy measure of how subjectively "threatening" a prospection may appear to the participant. Possible future research could include the use of SAM for a measure of dominance to investigate possible differences between High and Low Anxiety groups, or GAD and Control groups. This woud allow for analyses of meta-cognitive ratings between groups – GAD/Subclinical Anxiety participants may rate their negative future prospections (EFT-Negative) as more dominant than Asymptomatic Controls.

Neurophysiological Differences

Hypothesis 2: *There will be significant neurophysiological differences (as measured by EEG) between High Anxiety and Asymptomatic Control groups (**Accept**)*

5.5 While there were no clear cognitive differences in EFT between groups – based on the above information – there were significant neurophysiological differences. Episodic future thinking (EFT) and Episodic Memory (EM) is believed to recruit a core network of brain regions, referred to as the Episodic Core Network. This functional network comprises areas that overlap with the Default Mode Network (DMN), a recently heavily investigated neural network with connotations of self-referential processing at resting/no-stimulus (conscious) state (Andrews-Hanna et al., 2010; Spreng & Grady, 2010; Andrescu et al., 2014), and introspective meditation (Fingelkurts, Fingelkurts & Kallio-Tamminen, 2016). Key findings from visual analyses within this project indicate that High Anxiety participants, during negative prospection (EFT-Negative tasks), showed peak activity in visuospatial (occipital lobe) and self-referential (PCC) neural regions of interest; Low Anxiety participants showed peak activity in the superior temporal gyrus and medial temporal lobe – both associated with scene-construction, episodic memory and EFT (Addis et al., 2007).

5.6 The Occipital Lobe has been implicated as the brain's centre of visuospatial processing, and has long been associated with processing external visual sensory information. However, more recently it has been studied for its involvement in EM. For example, Kukolja et al. (2016) found that EM deficits (specifically for information consolidation) in older adults were related to a failure to increase connectivity of the lingual gyrus (BA17) to the broader DMN. Similar neurophysiological deficits have been found in patients with Bi-polar Disorder during the encoding stage of EM tasks, with lower activity in the lingual gyrus, anterior cingulate gyrus and precuneus compared to controls (Oertel-Knöchel et al., 2014). Furthermore, Maratos et al. (2001) found that the lingual gyrus of the occipital lobe, and the PCC were implicated in the retrieval of contextual information for *negative* EM tasks (see below for further discussion). Interestingly, activity in the occipital gyri has been shown to correlate with level of episodic detail produced during EM tasks (Viard et al., 2011). However, findings from Viard et al. (2011) suggest that in healthy participants, this activity was specific to episodic memories compared to EFT, as memories were more episodic than prospections in general. Therefore, when applied to

the results of the current study, there is an empirical basis for suggesting that High Anxiety participants were producing *more episodic* prospections for negative events, with more contextual information compared to neutral prospections, and compared to Low Anxiety participants.

5.7 The posterior cingulate cortex (PCC) has a wide-range of functions within the DMN, and in EFT and EM processing respectively. Irish et al. (2015) found that the PCC plays a key role in the task of scene construction, the atemporal version of EM and EFT whereby no temporal direction has been specified – participants simply imagine a scene. Interestingly, this area appeared key to performance across the Alzheimer's Disease and Control groups within the study, which suggests that despite neurodegenerative atrophy in other regions associated with the dementia (hippocampus and temporal regions, for example), the PCC was the specific region implicated in overall scene construction. EFT, EM and scene construction all rely on similar underlying cognitive and neurological factors, and therefore it is reasonable to infer that increased PCC activity correlates with a *more episodic* prospection during EFT – as seen in the current findings for the High Anxiety x EFT-Negative condition. The PCC also plays a role in generating visuospatial imagery (Cavanna & Trimble, 2006; Irish et al., 2015). This appears to interact with peak activity within the lingual gyri of the occipital lobe, which is also implicated in visuospatial processing during episodic tasks. The PCC is thought to play a key role in the consolidation of complex novel information with stored semantic (schema) information during the process of episodic memory tasks (Bird et al., 2015). This highlights an important potential role of the PCC during EFT – to consolidate the individual's stored schemata (cognitive script-like representations of "how the world works" in certain situations; Reinecke, Becker, Hoyer & Rinck, 2010) to generate a new hypothetical event or simulation. This also supports the Constructive Episodic Simulation Hypothesis (Schacter & Addis, 2007), which states that previously stored knowledge is flexibly combined to form a novel simulation – the prospection. In the case of GAD, for example, this could indicate that the individuals schemata predicts a negative event to be threatening as a matter of course. However, the nature of the episodic prospections produced within the present study was not measured and this leaves the possible correlation between negative-bias and content of prospections uninvestigated. Furthermore, Irish et al. (2018) found that cortical thinning of the PCC due to Frontotemporal Lobar degeneration (dementia) is related to deficits in *recent* autobiographical memory performance. This suggests that the PCC is involved in processing *recent*, personally significant information more than distant, more historical information. Therefore, the PCC may be sensitive to temporal distance. Within the opposite temporal framework (EFT), increased activity within the PCC may indicate how immediate or temporally close the prospection appears to the individual. Applied to the findings of the present study, this could indicate that the High Anxiety group were processing their negative prospections as more immediate (closer in the future) than Low Anxiety participants – despite the standardised temporal instructions (*within the next 5 years*). However, no measures for perceived temporal distance were taken and further research is needed to investigate this possibility, as it would further clarify the

role of the PCC and its potential sensitivity to perceived temporal distance of prospections or memories.

5.8 A further significant finding is most prominently displayed in the Topographic Maps from Chapter FOUR (see Fig. 5b). Low Anxiety participants displayed right-hemispheric dominance in the temporal regions across most conditions, while High Anxiety participants displayed hemispheric lateralisation at temporal regions – with a slight left-temporal dominance in peak amplitude. This difference was found to be statistically significant ($p < .001$), and sLORETA suggests that the positive amplitude may be related to activity in the left medial temporal lobe (MTL) and superior temporal gyrus. The MTL plays an important role in EFT and EM (Szpunar et al., 2007; Addis et al., 2009; Schacter et al., 2012; Hzu & Sonuga-Barke, 2016), and many studies have concluded that increased activity positively correlates with future temporal direction compared to imagining the present (scene construction) or past (Andrews-Hanna et al., 2010; Xu et al., 2016). While this would implicate the MTL as being temporally sensitive and provide evidence for how it functions differentially across "mental time-travel" tasks, a recent review and study by Palombo et al. (2018) suggests otherwise. Activity within the MTL appears to be increased when emphasis is placed on the spatial context of the imagined scanario (Palombo et al., 2018). Therefore, the MTL plays an important role in the process of scene-construction specifically – the atemporal version of EFT (see above) – and is not necessarily related to EFT more than EM. Palombo et al. (2018) critiques previous work investigating the MTL's role in episodic thinking (future vs present), suggesting that methodological issues (such as measures or tasks used) conflated the separate processes of scene-construction and EFT. For example, Xu et al. (2016) utilised a procedure which placed greater emphasis on scene-construction for future temporal (EFT) tasks compared to present (scene construction). Palombo et al. (2018) investigated this by adjusting the methodology used in Andrews-Hanna et al. (2010) and found that high scene-construction tasks elicited greater functional activation (fMRI data) compared to low scene-construction tasks. A slight left-MTL dominance was found for high scene-construction tasks. Furthermore, the results showed no significant effect of temporal direction (future vs present) on MTL activity. When taken together with the results of the present study, one could infer that the greater lateralised activation of both right and left MTLs present in the High Anxiety group across EFT tasks reflects a greater emphasis on scene-construction overall. Specifically, this might suggest that the prospections generated by the High Anxiety group were more spatially or contextually specific than the Low Anxiety group. Together, these two factors indicate that prospection is more episodic than semantic in nature, which seems to be the case here. Future research into this potential relationship would be needed to investigate any such correlation. Furthermore, there are other studies that have investigated the functional differences between the left and right MTL – relevant to the right-hemispheric dominance of the Low Anxiety group. Findings from studies into patients with damage to their right or left MTL point to different deficits in perspective processing tasks – namely, allocentric vs egocentric spatial memory tasks (Lambrey et al., 2008). Right MTL structures – including the right hippocampus – are implicated in imagining a scene from an alternative visuospatial perspective (allocentric); according to impairments

demonstrated by patients who had undergone right MTL surgery for epilepsy (Lambrey et al., 2008). Interestingly, the left MTL was sensitive to egocentric (first-person) visuospatial perspectives and this indicates a specialisation for both left and right MTLs for processing perspectives. Furthermore, patients with unilateral MTL epilepsy retain their abilities to construct gist-like episodic memories (the initial construction phase is relatively unaffected), however, they are lacking in detail due to the neural obstruction during the elaboration process. McCormick et al. (2018) found that patients with left MTL epilepsy recruited neocortical regions, including the ventromedial prefrontal cortex (vmPFC) during elaboration phases for episodic retrieval tasks. Healthy controls however, recruited bilateral hippocampal regions, including the MTL, during their more episodic retrieval. Bilateral hemispheric MTL activation is therefore paramount to constructing detail-rich episodic (autobiographical) memories, due to its role during the elaboration phase of the episodic process (McCormick et al., 2018). High Anxiety participants demonstrated increased bilateral activation of MTL areas across EFT conditions compared to Low Anxiety participants. Combine this with evidence suggesting that right MTL is associated with allocentric perspective processing (external visuospatial details), while the left MTL is associated with egocentric perspective (internal, personally relevant visuospatial details); and a clear pattern begins to emerge. Across all EFT conditions, High Anxiety participants recruited regions of the Episodic Core Network that have been correlated with processing scenes (episodic simulations) that are more spatially and contextually rich, and with greater level of detail. This conclusion is tentative, due to the small sample size within the present study. However, it does follow findings from cognitive research into anxiety disorders, whereby prospective cognitions (future thoughts) are predominantly worrisome in nature and involve a threat to the individual.

sLORETA Findings

Hypothesis 3: *There will be significant differences between groups in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Episodic Future Thinking (**Accept**)*

5.9 Statistical analyses of sLORETA results suggested significant differences between groups in the recruitment of neural regions comprising the Episodic Core Network. During the earlier 50ms time window (275-325ms) significantly greater recruitment was found in High Anxiety participants (compared to Low Anxiety) of the left middle frontal gyrus (MFG; BA 09), left PCC (BA 23), and left MTL (BA 28, 35 and 36). As discussed above, increased recruitment of the left MTL is associated with egocentric visuospatial processing, future-oriented scene construction, and is important to EM and EFT (Szpunar et al., 2007; Lambrey et al., 2008; Addis et al., 2009; Schacter et al., 2012; Hzu & Sonuga-Barke, 2016; Palombo et al., 2018); increased recruitment of the PCC could be related to more episodic constructions and is particularly sensitive to recent (temporally sensitive) events (Irish et al., 2015; Bird et al., 2016). The left middle frontal gyrus (BA 09) of the mPFC is associated with directing attentional resources to emotional stimuli and the expectancy of emotional stimuli (Bermpohl et al., 2006). Also, as suggested by Zaretsky,

Mendelsohn, Mintz, & Hendler (2010), increased acitivity in the mPFC is implicated in processing of uncertain threats; and Wheelock et al. (2014) suggest that the mPFC is involved in processing unpredictable threats. Therefore, when the above findings are taken together it is reasonable to suggest that the significant differences between groups reflect differences in early affective processing. Specifically, High Anxiety participants recruit areas that allocate attention to emotional stimuli – including unpredictable or uncertain threatening stimuli – more than Asymptomatic Controls.

5.10 Within the later 50ms window (775-825ms), High Anxiety participants recruited the PFC, mPFC, Lateral Temporal regions, and MTL significantly more than Low Anxiety participants during EFT tasks. As in the earlier time window, High Anxiety participants recruited neural regions associated with allocation of attention to emotional (unpredictable or uncertain threatening) stimuli, and areas associated with egocentric visuospatial processing, and future-oriented scene construction significantly more than Low Anxiety participants. These regions are integral to the process of EFT (and EM), as discussed above. Furthermore, High Anxiety participants recruited Left BA 21 – Middle Temporal Gyrus (MTG) – significantly more than Low Anxiety participant. The MTG is a key neural region for the integration of of semantic, visual and auditory information (Visser, Jefferies, Embleton & Ralph, 2012). This could indicate that High Anxiety participants generated more multisensory semantic prospections during EFT tasks compared to Low Anxiety participants. Particularly interesting is the significantly greater recruitment of the Right BA 11 – the Orbitofrontal Gyrus (OfG) – an area that is associated with recognition of emotional context (Maratos et al., 2001), and emotional enhancement of memories (Kumfor, Irish, Hodges & Piguet, 2014). Significantly greater recruitment of the OfG (and increased connectivity with the Left Amygdala) has been found in patients with Social Anxiety Disorder (SAD) compared to healthy controls; and suggestions were made that this led to significant differences in the processing of social and emotional situations (Geiger et al., 2016). Beer et al. (2003) found that patients with damage to their OfG performed significantly worse than healthy controls in tasks requiring self-conscious emotional processing and this had a subsequent negative impact on their ability to regulate their social behaviours. Similar findings come from Kreuger et al. (2016) when examining behavioural disinhibition within dementia patients. Socioemotional disinhibition was directly associated with neural atrophy and lesser recruitment of the OfG, suggesting it plays a central role in regulating behaviour and emotional processing in social situations. Taken together, the significantly greater recruitment of the OfG within High Anxiety (relative to Low Anxiety) participants during this later stage (775-825ms) indicates greater emphasis on socioemotional processing, and potentially more emotionally vivid prospections. However, these findings would require replication and supporting evidence from measures of the content of participants' EFT – such as the adapted-AI (Addis, Wong & Schacter, 2008).

5.11 Of particular interest to this project, are the statistically significant differences during negative EFT tasks – as these are qualitatively linked to worry, a defining feature of anxiety disorders such as GAD (APA, 2013). Significantly higher recruitment of the Right BA 13 (Insular Cortex) and the Right BA 21 (MTG) was found in High Anxiey participants compared to Low Anxiety participants. The Insular Cortex has been implicated in the

development of meta-memory – the human neurocognitive capacity to introspectively examine the accuracy of memories (Fandokova et al., 2017). As children develop through ages 7-15 years of age, improvements in meta-memory is associated with cortical thinning of the anterior insula and increased thickness in the vmPFC. Meta-memory is intrinsically similar to episodic memory and may rely on autonoetic consciousness (Tulving, 2001) to facilitate such introspection. Further support for this postion can be found in results by Philippi et al. (2017), who found that neural atrophy (from Alzheimer's Disease) in the Insular Cortex (and mPFC) was related to a reduced sense of self. This is an important finding, as it suggests the insular cortex may play an important role in facilitating the neurocognitive faculty of autonoetic consciousness; which is key to introspective processes such as EFT. Arzy et al. (2009) found the insular cortex to be recruited during mental time travel into both past and future, suggesting it is integral to the underlying neural network of EM and EFT. Therefore, there is some evidence to suggest that the insular cortex is implicated in self-referential introspective processing, autonoetic consciousness and both EM and EFT. The insular cortex also has a relationship with anxiety disorders. For example, increased anticipatory anxiety (particularly related to predicted pain) is positively correlated with increased recruitment of the insular cortex (Lin et al., 2013). Terasawa, Shibata, Moriguchi & Umeda (2013) found that high social anxiety levels were positively correlated with increased activation of the right anterior insular. They also suggest that this increased recruitment is associated with increased introspective monitoring and this is a significant contributing factor to the participants' high anxiety levels. Liu et al. (2015) utilised fMRI and found that increased amplitude of low-frequency fluctutations (ALFF) in the right dorsal anterior insular cortex was related to increased anxiety in anxious depressed patients relative to both healthy controls and depressed patients in remission. Shin & Liberzon (2010) also note that activity in the insular cortex is heightened across anxiety disorders. Another important role of the insular cortex (right anterior insular specifically) is to serve as an integrated control hub in the processing of multi-sensory information (Chen et al., 2015). Furthermore, there is evidence to suggest the insular cortex is central to the processing and representation of the material self, due to its wide-spread involvement in multi-sensory integration and interoception as it relates to self-other processes (Tajadura-Jiménez & Tsakiris, 2014).

5.12 From the above findings, it is reasonable to assume that the positive recruitment of the right insular cortex (BA 13) in High Anxiety participants (relative to controls) is significant. Although participants within the present study were Subclinical, the neural activity during Negative EFT tasks is similar to what could be expected of clinical populations. Increased recruitment of the insular cortex supports the notion that High Anxiety participants were processing negative future events with higher concurrent levels of interoception and multisensory integration. The combined functions of the insular cortex (anticipatory anxiety, interoception, multi-sensory integration and its relation to the self) indicate that its recruitment during negative prospections may correlate with episodic thoughts that are self-relevant and involve physical and affective arousal. Unfortunately, as there was no measure of EFT content (as possible using the adapted-AI), it is difficult to draw such a conclusion. Future research may utilise such a

measure as to investigate this possible relationship. For now however, the suggestion is tentative and requires further empirical investigation.

The Effect of Valence

Hypothesis 3a: *There will be significant differences between groups in the recruitment of neural regions (as estimated by sLORETA) comprising the Episodic Core Network during Negative Episodic Future Thinking (**Accept**)*

5.13 Across groups, there was an effect of valence on the differential activation of neural regions – as predicted. Specifically, negative valence stimuli were associated with increased (although not statistically significant) bilateralisation of mean amplitude at temporal regions in Low Anxiety participants (see topographic maps *Fig 4a & 4b* in Chapter FOUR); and peak activity in the lingual gyrus (OL) and PCC in High Anxiety participants (sLORETA images *Fig. 6a & 6b* in Chapter FOUR). Therefore, negative affective stimuli elicits a different neurophysiological pattern (mean amplitude) in High Anxiety and Low Anxiety participants. This suggests two possibilities: a.) high trait anxiety results in a significantly different affective processing of the cue word itself; or b.) high trait anxiety results in different negative prospections being generated by participants. For example, findings from Laeger et al. (2014) suggest that Subclinical Anxiety predicts increased amygdala activation when processing negative emotional words compared to neutral. This may support the first possibility; the neurophysiological differences found within the present study may reflect similar differences in affective processing of the cue words. However, increased amygdala-dlPFC coupling was also associated with emotional regulation in Subclinical Anxiety groups processing negative words in Laeger et al. (2014). No such dlPFC activation appeared within the current study. Furthermore, previous neurophysiological research into attentional biases for emotional words has focussed on early affective processing time windows. For example, Wabnitz, Martens & Neuner (2016) found significant differences in ERP components in participants with Social Anxiety Disorder (SAD) compared to controls when presented with emotional words. Specifically, a diminished P100 ERP was present in SAD patients; heightened Early Posterior Negativity (EPN) – suggesting hypervigilance to emotional words. No difference between SAD and Control groups was found for N400 ERP component. However, N400 was sensitive to emotional vs. neutral cue words – demonstrating the effect of valence on neurophysiological responses. For the purpose of the present study's analysis, a 50ms time window approximating the LPC (775-825ms after stimulus onset) was used because the LPC is believed to represent stronger episodic memory (and possibly prospections); furthermore, it relates specifically to self-knowledge compared to knowledge of others (Coronel & Federmeier, 2016). The early attentional differences that seem to dissappear with later neurophysiological activity (from N400 – 400ms onwards) may not impact on the results for analyses focussing on 800ms after stimulus onset. Furthermore, findings from Dresler et al. (2009) suggest that

emotional interference during a Stroop tasks is not effected by trait anxiety – but rather by state anxiety. The participants level of anxiety during the experiment predicted higher attention to emotionally salient information compared with others.

5.14 Based on the above, the second possibility appears more likely – High Anxiety participants generated different negative prospections than Controls. Indeed, although there were no statistically significant differences between groups (on self-reported level of episodic detail), there was a significant positive correlation between GAD-7 scores and EFT-Negative scores on the behavioural measures ($r = .61$, $p < .01$). While no further data was collected regarding the qualitative content of these prospections, it appears – based on statistically significant neurophysiological differences – that each group may have generated negative prospections differently. This corresponds with existing empirical evidence suggesting that future thoughts in GAD are dominated by an expectancy of anxious experiences compared to other psychiatric disorders or the general population (see Ghahramanlou-Holloway, Wenzel, Lou & Beck, 2007).

5.15 It is also reasonable to infer that across groups, negative affective stimuli elicited *more episodic* prospections. The Low Anxiety group (asymptomatic controls) showed increased bilateral temporal activity; whereas the High Anxiety group demonstrated peak amplitudes in OL and PCC regions. The differential activation of these ROIs demonstrates the mediating role that trait anxiety played when generating prospections. Further specification via source estimation (sLORETA) confirmed that High Anxiety participants recruited neural regions associated with introspection, socioemotional processing and multisensory integration significantly more than Low Anxiety participants during EFT. Future research should focus on investigating the possible mediatory effect of anxiety on the content of negative EFT and examine its possible neurophysiological correlates. Neutral stimuli appeared to elicit peak activity reflective of baseline recruitment of the episodic core network for each group, with right hemispheric dominance for Low Anxiety participants. This suggests that the prospections produced were generally less episodic in their content compared to emotionally salient (affectively primed) prospections. It also provides further evidence for the role of trait anxiety (on a neurophysiological level) mediating the processes involved in episodic future thinking, even for neutral – not emotionally salient or threatening – stimuli.

5.16 Within the current study, EFT-Positive data was not included in the analysis due to a technical error during the data collection sessions. Specifically, the data for EFT-Positive tasks was only recorded for a 1ms window instead of the intended 50ms window. Post-hoc examination of the e-Prime 2.0 script did not indicate any particular reason for such a recording error. However, the focus of the study was to examine inherently negative prospections (threatening or worrisome thoughts) in those with higher trait anxiety compared to asymptomatic controls – so the loss of such data is not significant. However, it is important to note that future research into EFT differences arising from trait anxiety should consider the role of positive valence stimuli. There may be a similar pattern of neurophysiological activity in prospections that are highly affective (positive or negative) that is the cause of the difference that was found within the present study. This would mean that high trait anxiety was related to differential activation of areas

within the episodic core network related to affective stimuli overall – regardless of its valence. Szpunar & Schacter (2013) found that repeated simulation increased the participants' likelihood ratings for future events – but only for emotional ones. This points to a potential similarity in negative and positive future event processing. However, Wu et al. (2015) found that participants with Generalized Anxiety Disorder (GAD) demonstrated a negativity bias for future events, rating negative future events as more plausible than asymptomatic controls. So far, the empirical consensus is that anxiety is related to a pessimistic threat-bias for future events, which is inherently negative in nature (Miloyan, Bulley & Suddendorf, 2016).

Neurophysiological Similarities

5.17 While there were significant neurophysiological differences between groups, there was a marked overlap in neural activity. For example, the main regions of the Episodic Core Network were activated across all EFT tasks. Based on previous research findings, this indicates that the participants were successfully producing episodic prospections when completing the task presented to them. This indicates that the procedure utilised here was therefore appropriate to ellicit such prospections. If this is the case, then results are (somewhat) comparable to other such studies that examine episodic processes, as the pattern of neurophysiological activity is similar. Therefore, the results of the present study provide more empirical support for the existence of a discrete functional neural network involved EFT – the Episodic Core Network (Addis et al., 2007) – consisting of MTLs, PCC, medial PFC, retrosplenial cortex, lateral temporal regions and frontal regions (see Chapter TWO). Such a large-scale functional network that overlaps significantly with the DMN, is an exciting prospect for future research to investigate. Differential activation of this network can be correlated with deficits or positive performance in episodic tasks and further knowledge can be gained for the discrete roles each ROI plays. This has already begun with research into dementia by Irish et al. (2018; see above), but there is still significant room for further investigation. For example, transcranial direct current stimulation (tDCS) studies could also provide supporting evidence for the discrete contributory functions of each region. Zwissler et al. (2014) found that stimulation of the left dlPFC impacted the accuracy of memory encoding and subsequent recall; similar to Leshikar et al. (2017), who found that stimulation of left dlPFC during encoding improved subsequent recall – even after one day. These tasks were not episodic in nature, rather recruiting basic semantic memory processes and recognition. However, Chen et al. (2016) found that tDCS over the left posterior parietal cortex (LPPC) was causally linked to improvements in episodic memory performance. Therefore, the potential to co-ordinate findings from EEG, ERP, sLORETA, fMRI and tDCS studies allows for stronger claims to be made about the functional neural network underlying these processes. The results of the present study also provide support for the Constructive Episodic Simulation Hypothesis (Schacter & Addis, 2007), as the neurophysiological activity at earlier stages (275-325ms) were reflective of concurrent recollection of semantic, multisensory information and initial emotional processing. The later stage (775-825ms) involved recruitment of higher order neural regions that integrate multisensory information, generate visuospatial information and

emotional processing. This would indicate that two distinct phases exist, as posited by Schacter & Addis (2007): 1.) initial recollection of stored semantic, schematic, emotional and sensory information, and 2.) reconstruction of this information into a novel future simulation with subsequent emotional processing.

5.18 Cognitive research into EFT has posited the *constructive episodic simulation hypothesis*, which involves a variety of high-level cognitive processes that take stored information and flexibly recombine into a novel new scenario (Schacter & Addis, 2007). This hypothesis explicitly states that the overlap between EFT and EM is great at both the cognitive and neurophysiological level, as the same core networks and regions are differentially recruited across both functions. Furthermore, this field of research has rapidly expanded to investigate EFT deficits across clinical populations. For example, Mercuri et al. (2016) demonstrated how long-term opiate abuse can negatively impact on the quality and quantity of episodic future thoughts. There are multiple studies into EFT deficits in various dementias (see Duval et al., 2012; Irish, Hodges, Addis & Piguet, 2012; Irish, Hodges & Piguet, 2013; Hsaio, Kaizer, Fong & Mendez, 2013; Irish et al., 2016), which allow for inferences to be made regarding the role these discrete atrophied neural regions play when functioning normally. For example, Semantic Dementia presents a unique challenge and insight into the differences between EFT and EM. Sementic Dementia patients are able to retain some of their EM capabilities, but appear to decrease significantly in their EFT capacity. This allows for investigation at the cognitive and neurophysiological level as to how these differences may be related to Semantic Dementia's discrete neurodegenerative pathology that atrophies the anterior temporal lobes (Hodges & Patterson, 2007). One can tentatively infer that the anterior temporal lobes play a unique role within the Episodic Core Network, particularly in prospective simulations (EFT) compared to EM.

Methodology and Future Research

5.19 The present study is the first – to the best of the researcher's knowledge – to investigate possible cognitive and neurophysiological (neurocogntive) differences during EFT based on trait anxiety. To do this, a quasi-experimental design was utilised that divided participants into High Anxiety (Subclinical) and Low Anxiety (Asymptomatic Control) groups. However, it is important to emphasise that these groups were all non-clinical – insofar as, no participants had a current or previous diagnosis of an anxiety disorder (or any other mental disorder), and had not received psychotherapy or drug treatments. Therefore, it is important to note that differences found between these two *methodologically constructed* groups are reflections of possible differences within the general, non-clinical population who's trait anxiety varies on a spectrum. A diagnosis of GAD for example, would require that the level of recurrent fear and anxiety be difficult to control, and generalised to the point of impacting significantly on daily functioning; and have been occuring for three months or more (APA, 2013). This indicates a key cut-off point from which the "subclinical" spectrum of trait anxiety progresses into a maladaptive anxiety disorder. Taking this developmental approach to anxiety disorders may also be prudent given the results of the current study. For example, the differences found between groups could indicate that an individual is approaching the clinically

significant cut-off point in the near future. From this perspective, the High Anxiety sample within this project could be seen as “pre-clinical” also because Subclinical Anxiety is predictive of future diagnosis (Wolitzky-Taylor et al., 2014). Indeed, some participants within the High Anxiety group did score in the category of “Severe Anxiety” for the GAD-7 psychometric measure, which does not constitute a diagnosis on its own but does carry important connotations of (potential) impact on everyday functioning. The researcer is keen to emphasise these points for the purpose of post-hoc discussion about this project’s key findings. Discrete neurophysiological differences were found at two levels of analysis – ERP-style statistical analysis at key electrode sites; and sLORETA source estimation. Furthermore, these differences appear to reflect pre-existing cognitive knowledge for anxiety disorders.

5.20 Alternative methods and measures could have been used to complete the present study and answer the research questions. For example, there have recently been advancements in the development of self-report measures specifically for future-oriented thinking – namely, the future-oriented repetitive thought (FoRT) scale (Miranda, Wheeler, Polanco-Roman, & Morruín, 2017). This measure combines items from many other established clinical self-report measures, including the PSWQ used within the present project. It consists of three subscales for discrete categories of repetitive future thinking: pessimism, goals and positive indulging. The scale would be useful for future research into this area of EFT, however, within the proposed study it was felt to be too broad a scale with insufficient application in other empirical research – as a newly developed tool. Further replication of its reliability and suitability for episodic research is needed before it is adopted here. Furthermore, the adapted-AI (Addis & Schacter, 2008) has been shown to produce a large quantity of information from participants that the researcher must analyse and score for episodic details and semantic information. While this measure has been used in previous research into EFT and was ranked as the most reliable measure at present by Ward (2015), there are issues with incorporating it within an EEG project. Firstly, the significant amount of time that would be needed for participants to verbalise their EFTs between cue words would cause potential issues with the EEG sensor net itself, as the sensors are known to begin drying out and becoming less accurate from 30 minutes onwards. This would therefore cause problems with scalp impedance and accuracy of EEG measure – the main subject of the project. Even if the Adapted-AI was used after the EEG session, it would become unclear whether participants would be remembering their previous prospections (generated moments ago) or truly engaging in prospection. Other issues include the significant time commitment needed to transcribe 54 events descriptions per participant, which within the present study would result in 594 event transcriptions (54 events x 11 EEG participants). The adapted-AI has been utilised within fMRI studies; however, fMRI is not subject to the same physiological skin conductance issues that EEG is limited by.

5.21 Neuropsychological research has limitations with regards to ecological validity due to its very nature of laboratory environments, with high levels of control and simple stimuli (Parsons, 2015). However, there are advancements in the field of neuroscience to increase the ecological validity of experiments using virtual reality (Bohil, Alicea, &

Biocca, 2011; Parsons, 2015). While these lend themselves to improvements in future research, the present study is limited to the use of standardized written emotional stimuli (ANEW). However, the benefit of using these stimuli is that the experiment has comparative ecological validity to existing research and therefore is able to contribute to discussions in the field as it stands. Future research should endevour to recruit more participants, particularly those with existing diagnoses to compare results. Furthermore, to gain information about the qualitative content of the prospections generated during the EFT tasks, alternative methodology should be employed. Specifically, the researcher recommends that future research utilise fMRI technology along with the adapted-AI to gain higher spatial resolution, and detail-rich transcriptions of participants' prospections.

Summary

5.22 The present study was the first – to the best of the researcher's knowledge – to investigate possible neurophysiological differences during EFT based on trait anxiety. Neurophysiological differences between groups (High vs Low Anxiety) were found at three levels of analysis: a.) statistical analyses of mean amplitude at electrodes at P300 (275-325ms) and LPC (775-825ms) after stimulus presentation; b.) peak activity (sLORETA souce estimation) at LPC (775-825ms) after stimulus presentation; and c.) statistical analyses of sLORETA source estimation data at P300 (275-325ms) and LPC (775-825ms) – including specific analyses of neural activity during Negative EFT. The results indicate that both groups recruited areas of the Episodic Core Network as expected, providing support for this functional pattern of neural activity. However, High Anxiety participants showed increased bilateral activation in temporal regions (topographic maps) across valence conditions, and peak activity was localised to the lingual gyrus (OL) and PCC in negative EFT tasks. Low Anxiety participants demonstrated right hemispheric dominance across conditions, with slightly increased bilateralisation of temporal regions for EFT-Negative tasks. Further analyses of sLORETA data revealed statistically significant differences in the recruitment of regions between groups during EFT. Specifically, High Anxiety participants (compared to Asymptomatic Controls) recruited the MTL, mPFC, OfG and MTL significantly more during EFT tasks. Interesting to note is the significantly greater recruitment of the OfG and MTG in High Anxiety participants during Negative EFT tasks, as these tasks are more directly related to worry.

Conclusion

5.23 The nature of the neurophysiological differences suggest that High Anxiety participants generated negative prospections utilising more visuospatial, socioemotional, introspective and schematic information than Low Anxiety participants. Existing empirical knowledge indicates that anxiety disorders are characterised by uncontrollable, repetitive worrying about the future, and a negative threat-bias towards future events. Therefore, it is reasonable to infer that these neurophysiological differences reflect some relationship to this negative threat-bias to future events. The present study provides a basis for further research into the neurophysiological differences during EFT related to trait anxiety, and anxiety disorders such as GAD. Furthermore, it provides the first set of neurophysiological correlates (differential neural

activity) to anxiety's prospective and anticipatory negative threat-bias and how this relates to EFT.

Word Count – 29,376

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Distinguished scientific award for the applications of psychology: Aaron T. Beck. (1990). *American Psychologist*, *45*(4), 458–460. https://doi.org/10.1037/h0091609

Appendix A: Recruitment Poster/Advertisement

PARTICIPANTS NEEDED

Neuroscience Study on Worry

Get your brain scanned!

I am recruiting participants ages 18-30 for my MSc Psychology study on worry, anxiety and future thinking. Participation will involve an EEG (**brain scanning**) session that lasts approximately 1.5 hours.

Criteria are:

- Age 18 – 30, male or female
- No previous or current diagnosis of mental disorder
- No previous or current use of medication for mental health (e.g. antidepressants)
- No previous or current talking therapy or counselling

If you match the above criteria and wish to take part, or know someone who would – please e-mail Jolian on:

Appendix B: Information Sheet & Consent Form

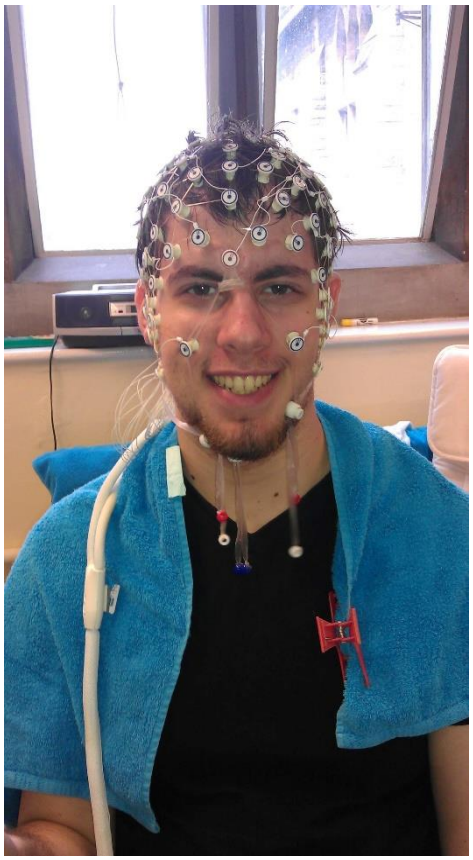
UNIVERSITY OF GLOUCESTERSHIRE

Title: 'Worry on the Brain': Information and Consent Form

Researcher: Jolian Ardolino

Purpose of data collection: MSc Thesis

Details of my participation: To complete two short questionnaires, followed by an EEG (electroencephalography) task where I will be asked to remember/imagine a series of past/future events.



Purpose of the study/What to expect:

As humans, we are able to remember events/episodes in our past in a very realistic way – this is known as "episodic memory." Similarly, we all have the ability to imagine future events/episodes in this way – this is known as "episodic future thinking."

This study aims to investigate episodic future thinking and its possible links to levels of anxiety and worry. All people worry and experience anxiety from time to time. Imagine a spectrum, from low to high levels of anxiety and worry. We all fall onto this spectrum somewhere, and at the very high end of the spectrum lie anxiety disorders, such as Generalised Anxiety Disorder (GAD). The purpose of this study is to look at individuals without an anxiety disorder who still vary on this continuum of worry and anxiety. To measure your personal levels of anxiety and worry, you will complete two short questionnaires (taking approximately 5 minutes). Your scores will place you in one of two groups, however, this is done after the experiment and no participants are able to see their scores (please see consent agreement below).

Following these questionnaires, you will complete the EEG task. This involves having an EEG sensor net placed on your head by the researcher – almost like a cap (see picture on left). Once the EEG net is in place, you will be required to sit in front of a screen to complete the main task of the experiment. The task involves remembering past episodes and imagining future episodes. You will be presented with a positive/negative/neutral cue word to prompt you, however, you are encouraged to elaborate on this freely and simply use this as a starting point for the process. You are required to do this while wearing the EEG sensor net and will be asked to reduce your movements as much as possible to avoid disrupting the reading (e.g. fidgeting, blinking, clenching teeth, moving tongue). The EEG sensor will be measuring electrical activity across regions of your brain while you complete the task and its important to obtain the cleanest reading possible.

If at any point during the experiment, you wish to stop or withdraw, please inform the researcher immediately. You may withdraw at any time within 4 weeks of taking part. There are **no negative**

consequences for withdrawing from the study, as our duty is to ensure your safety and wellbeing during the process. Your participation is entirely voluntary.

Also, please see the consent agreement below for instructions on withdrawing your data from the study *after* the experiment.

After the study is complete, the researcher will safely remove the EEG sensor net and will present you with a full written debrief of the study, verbally debrief you and answer any questions you may have relating to the research.

Consent Statement:

Please read the information below carefully and sign to indicate your understanding that:

1.) My participation is voluntary and I am free to withdraw from the study at any time during the course of the experiment with no negative consequences
2.) I am also free to withdraw my information from the study within 4 weeks of taking part by e-mailing the researcher and quoting my participant number
3.) I have been given a brief explanation of the purpose of the experiment and will receive a written and verbal debrief following the experiment to provide further information
4.) My data will be anonymised using a participant number and password protected by the researcher. Only the researcher and their supervisor/s will have access to this information
5.) Results from questionnaires at the beginning of the experiment are to be used only for the purposes of grouping participants, and these scores will not be made available to individual participants (i.e. I am unable request access to my scores on these questionnaires)
6.) The overall findings of the present experiment may be submitted for publication in a scientific journal, or presented at scientific conferences
7.) The study will take approximately 1 ½ - 2 hours to complete
8.) I am able to contact the researcher to obtain general information about the experiment using their e-mail address:

I am giving consent for data to be used for the purposes of the proposed study and all questions that I have about the research have been answered.

Participant Name:

Sign: …… Date: ……

Researcher Name:

Sign: …… Date: ……

Appendix C: Debrief Form

Debrief

Thank you for taking part in my experiment – I really appreciate it.

As you know by now, the experimental task was to remember past events and imagine future events related to a specific word. What you might be wondering is, "why?"

Purpose of the study

"Episodic future thinking" is a way of imagining a future event so that it seems realistic – like an "episode." This is similar to the way we can remember episodes in our past – "episodic memory." While there is a lot of general research into both - and some clinical research – there is little to no current research considering the relationship between anxiety and worry, and episodic future thinking. This is the first such study (to the best of the researcher's knowledge) to examine this possible relationship from a neurocognitive approach (looking at brain activity and thoughts).

As a participant, you completed two questionnaires designed to measure generalised anxiety, and worry. Your score on these questionnaires has put you into one of two groups: high vs. low anxiety. These scores *do not* equal a diagnosis – they are for measuring your general level of anxiety and worry. All scores have been anonymised using your participant number. Participants are not permitted access to their scores and they are used solely for the purpose of participant grouping.

The EEG section of the study: you completed a series of tasks whereby you thought of past or future episodes/events, relating to the cue word. While you were doing this in your mind, the EEG was measuring activity across regions of your brain (reading the electrical activity). There is already an array of neuroscience research into episodic future thinking, which has found a Episodic Core Network that activates as we use episodic memory or future thinking.

The hypothesis for the study, based on existing empirical knowledge, is that participants with high levels of anxiety and worry will perceive future events as more negative and potentially threatening than low anxiety participants. Therefore, it is proposed that these participants will recruit networks in the brain related to processing threats during the future thinking tasks. This was all measured using the EEG.

As a participant, you have the right to withdraw your data from the study within 4 weeks of taking part by e-mailing the researcher at: – just quote your participant number (below).

If you have any immediate questions, please ask now. Alternatively, please e-mail me and I will do my best to respond as soon as possible.

Thank you and all the best,

Jolian Ardolino

Support

If you are a student and feel in any way emotionally affected by taking part in the study, please contact the student Helpzone or Mental Health and Wellbeing Team (mhw@glos.ac.uk) for support and help with arranging Counselling.

Samaritans

Offering emotional support 24 hours a day

Tel: 116 123

Email: jo@samaritans.org

Web: www.samaritans.org

Sane Line

Offering specialist mental health emotional support 6-11pm everyday.

You can also email through their website.

Tel: 0845 767 8000

Web: www.sane.org.uk

Alternatively, contact myself ( ), Dr Edgar (gedgar@glos.ac.uk) or Dr Baker (sbaker1@glos.ac.uk) for signposting to the relevant professionals.

Appendix D: Measures Used - GAD-7 and PSWQ

NovoPsych

Client Information

Client Name	[redacted]
Date of birth (age)	

Assessment Information

Assessment	Generalised Anxiety Disorder Assessment (GAD-7)
Date administered	[redacted]
Assessor	
Time taken	

Results

	Value
Score	4
Percentile (female cohort)	59

Interpretive Text

This individual did not score in the anxiety range

Scoring and Interpretation Information

A raw score (from 0 to 21) is presented as well as a percentile rank based on the Lowe et al. (2008) community sample. Given that females score slightly higher than males, a percentile for each gender is presented - the appropriate gender percentile should be selected for interpretation.

Client Responses

		Not at all	Several days	More than half the days	Nearly every day
1	Feeling nervous, anxious or on edge	0	1	2	3
2	Not being able to stop or control worrying	0	1	2	3
3	Worrying too much about different things	0	1	2	3
4	Trouble relaxing	0	1	2	3
5	Being so restless that it is hard to sit still	0	1	2	3
6	Becoming easily annoyed or irritable	0	1	2	3
7	Feeling afraid as if something awful might happen	0	1	2	3

NovoPsych

Client Information

Client Name [redacted]
Date of birth (age) [redacted]

Assessment Information

Assessment Penn State Worry Questionnaire (PSWQ)
Date administered [redacted]
Assessor [redacted]
Time taken [redacted]

Results

	Value
Raw Score	69
Normative Percentile	100
Social Anxiety Percentile	80.6
GAD Percentile	54.9

Interpretive Text

This individual's responses indicate that they are likely to be a chronic worrier and in need of treatment to target this problem

Scoring and Interpretation Information

Scores range from 16 to 80 with higher scores indicative of higher levels of trait worry. A total raw score is given as output which is converted into three percentiles, comparing the total score to three different samples: An adult community sample (n = 244) showing the client's score in relation to the normal population (Gillis, Haaga, & Ford, 1995). A social anxiety disorder percentile comparing the client's score with those with social anxiety (n = 132) and a GAD percentile comparing scores to people diagnosed with generalised anxiety disorder (n = 28), (Turk, Fresco, Mennin & Heimberg (2001). Typically individuals with GAD will score highly on this measure compared to other anxiety disorders.

Client Responses

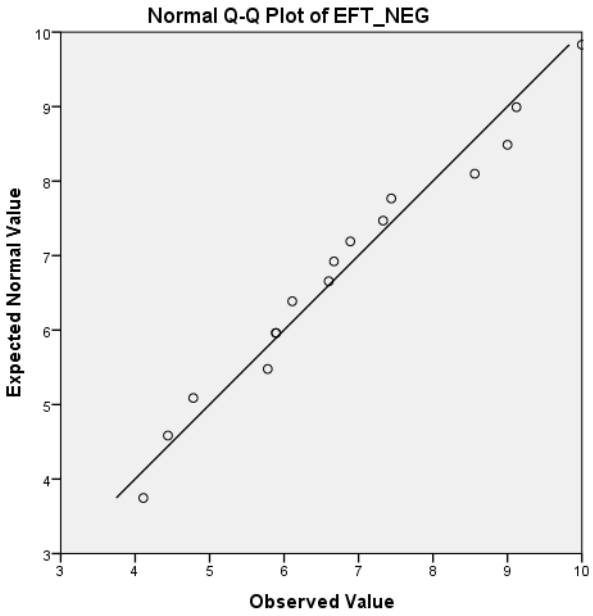
		Not at all typical	Rarely typical of me	Somewhat typical of me	Often typical of me	Very typical of me
1	If I don't have enough time to do everything, I don't worry about it.	5	4	3	2	**1**
2	My worries overwhelm me.	1	2	3	**4**	5
3	I do not tend to worry about things.	5	**4**	3	2	1

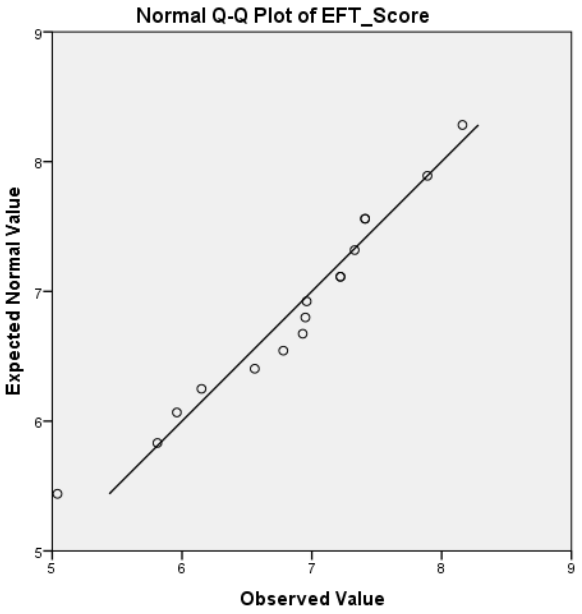
Appendix E – Descriptive Statistics Tables and Q-Q Plots

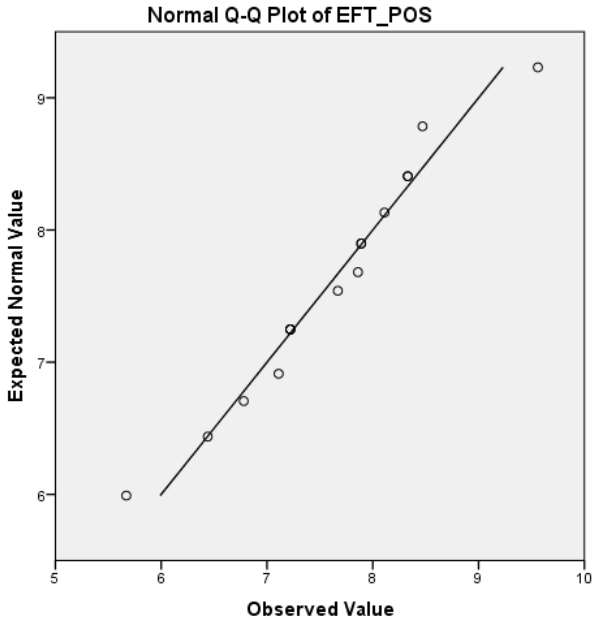
Cognitive Data – Descriptive Statistics

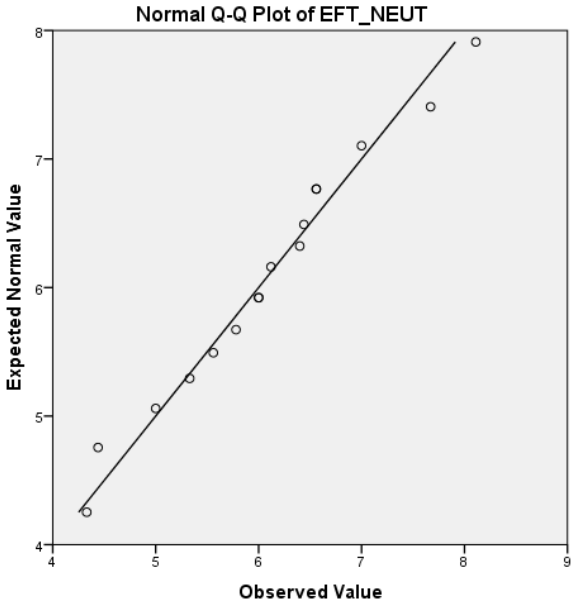
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
GAD7	16	1	20	10.38	6.217	.038	.564	-1.464	1.091
PSWQ	16	30	69	53.13	14.528	-.356	.564	-1.489	1.091
EFT_Score	16	5.04	8.16	6.8613	.80351	-.663	.564	.444	1.091
EFT_NEG	16	4.11	10.00	6.7881	1.71992	.293	.564	-.627	1.091
EFT_POS	16	5.67	9.56	7.6106	.91577	-.081	.564	.863	1.091
EFT_NEUT	16	4.33	8.11	6.0813	1.03421	.123	.564	.000	1.091

Q-Q Plots for EFT Scores









EEG Descriptives – Mean Amplitude – P300 (275-325ms)

	AnxietyGroup	Mean	Std. Deviation	N
LTempo	**HighAnxiety**	11.3896	2.68087	2
	LowAnxiety	-7.1945	.04957	2
	Total	2.0976	10.84061	4
PFC	**HighAnxiety**	2.4095	2.07960	2
	LowAnxiety	-4.0594	3.83278	2
	Total	-.8250	4.50418	4
RTempo	**HighAnxiety**	11.8133	2.03870	2
	LowAnxiety	12.3444	.32621	2
	Total	12.0788	1.23082	4
Occipital	**HighAnxiety**	-7.0224	5.46411	2
	LowAnxiety	15.8674	.54881	2
	Total	4.4225	13.59044	4
RPosterior	**HighAnxiety**	5.4678	.36953	2
	LowAnxiety	9.5122	.27742	2
	Total	7.4900	2.35021	4
LPosterior	**HighAnxiety**	11.4128	.93842	2
	LowAnxiety	3.7940	1.10833	2
	Total	7.6034	4.47793	4

EEG Descriptives – Mean Amplitude – LPC (775-825ms)

	AnxietyGroup	Mean	Std. Deviation	N
LTempo	**HighAnxiety**	12.6647	1.08373	2
	LowAnxiety	-5.2449	1.86411	2
	Total	3.7099	10.41477	4
PFC	**HighAnxiety**	4.4169	.48399	2
	LowAnxiety	-6.4464	4.72908	2
	Total	-1.0148	6.84612	4
RTempo	**HighAnxiety**	11.8782	1.29299	2
	LowAnxiety	12.1432	2.97038	2
	Total	12.0107	1.87663	4
Occipital	**HighAnxiety**	-11.2312	3.89204	2
	LowAnxiety	15.2497	9.39247	2
	Total	2.0092	16.37687	4
RPosterior	**HighAnxiety**	5.3962	1.57160	2
	LowAnxiety	9.8222	7.35655	2
	Total	7.6092	5.03915	4
LPosterior	**HighAnxiety**	11.6121	.82209	2
	LowAnxiety	4.9724	9.47849	2
	Total	8.2922	6.69834	4

sLORETA Descriptive Statistics Table – All EFT Tasks

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
LBA08	12	11.09	14.85	13.3137	1.40965	-.553	.637	-1.520	1.232
RBA08	12	8.71	12.69	10.2000	1.13995	1.211	.637	1.244	1.232
LBA09	12	7.71	12.23	10.0807	1.33480	-.435	.637	-.084	1.232
RBA09	12	5.35	7.43	6.6851	.65764	-1.242	.637	.752	1.232
LBA10	12	8.66	13.77	10.9403	1.61782	.081	.637	-.906	1.232
RBA10	12	8.21	13.53	10.2989	1.78028	.678	.637	-.998	1.232
LBA11	12	10.75	19.40	15.7973	3.30679	-.675	.637	-1.480	1.232
RBA11	12	9.55	20.51	15.7981	4.46106	-.671	.637	-1.620	1.232
LBA13	12	9.38	15.55	13.0317	2.41321	-.630	.637	-1.564	1.232
RBA13	12	5.96	10.76	7.8467	1.93113	.751	.637	-1.542	1.232
LBA21	12	11.61	14.10	13.0204	.81935	-.168	.637	-1.026	1.232
RBA21	12	15.02	20.11	17.3682	1.85087	.434	.637	-1.397	1.232
LBA23	12	24.28	29.68	26.6097	1.43242	.515	.637	.849	1.232
RBA23	12	17.48	20.12	18.7412	.78265	.452	.637	-.241	1.232

LBA24	12	6.62	11.53	9.1740	1.60432	-.357	.637	-1.122	1.232
RBA24	12	5.20	9.48	7.5573	1.56255	-.264	.637	-1.446	1.232
LBA25	12	17.56	23.17	19.8219	1.63352	.719	.637	.339	1.232
RBA25	12	11.51	21.89	18.2444	3.72987	-.795	.637	-1.095	1.232
LBA27	12	29.91	45.01	38.7170	4.99079	-.351	.637	-1.023	1.232
RBA27	12	7.89	22.35	16.1212	5.48773	-.607	.637	-1.510	1.232
LBA28	12	47.43	60.90	54.9451	4.41391	-.440	.637	-1.200	1.232
RBA28	12	26.78	39.04	34.7283	3.76715	-1.010	.637	.364	1.232
LBA29	12	17.30	22.81	19.8356	1.85033	.182	.637	-1.394	1.232
RBA29	12	16.51	20.42	18.2957	1.02201	.323	.637	.726	1.232
LBA31	12	14.51	23.85	18.7860	3.63481	.485	.637	-1.603	1.232
RBA31	12	13.12	20.25	15.7702	3.02391	.778	.637	-1.610	1.232
LBA32	12	7.24	10.14	8.3790	1.11113	.606	.637	-1.480	1.232
RBA32	12	5.37	8.25	6.7999	1.09878	-.209	.637	-1.616	1.232
LBA34	12	33.69	44.54	40.3356	3.38681	-.633	.637	-.356	1.232
RBA34	12	13.61	21.84	19.2192	2.60873	-1.074	.637	.377	1.232
LBA35	12	60.51	79.35	70.1613	6.23235	-.165	.637	-1.080	1.232
RBA35	12	15.71	32.71	27.0859	5.47014	-1.121	.637	.176	1.232

LBA36	12	60.65	75.93	68.7803	4.92745	-.343	.637	-.871	1.232
RBA36	12	30.48	48.62	41.6629	7.32702	-.779	.637	-1.539	1.232
LBA41	12	8.37	19.53	12.8982	4.61100	.586	.637	-1.683	1.232
RBA41	12	6.47	8.89	7.5093	.70861	.560	.637	-.247	1.232
LBA42	12	9.84	21.64	14.3942	4.73085	.725	.637	-1.556	1.232
RBA42	12	11.22	16.28	13.9636	1.55312	-.422	.637	-.720	1.232
LBA44	12	7.46	22.05	15.3127	5.88658	-.584	.637	-1.618	1.232
RBA44	12	7.18	13.51	10.0132	2.09356	.256	.637	-1.399	1.232
LBA45	12	13.10	21.10	16.0154	2.78398	.649	.637	-.864	1.232
RBA45	12	7.19	11.67	10.1025	1.27972	-1.414	.637	1.658	1.232
LBA46	12	12.40	21.47	15.7837	3.23247	.669	.637	-1.142	1.232
RBA46	12	7.68	14.78	10.3624	2.67076	.797	.637	-1.392	1.232
LBA47	12	9.47	17.22	13.7330	2.94934	-.571	.637	-1.569	1.232
RBA47	12	10.20	21.97	16.5245	4.45936	-.381	.637	-1.599	1.232
LHippocampus	12	34.74	50.00	42.6761	4.94266	.020	.637	-1.103	1.232
RHippocampus	12	19.90	33.19	28.1003	5.38759	-.769	.637	-1.546	1.232

Appendix F – ANOVA/ANCOVA Results Tables

EFT Scores

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power[e]**
Corrected Model	**EFT_Score**	.733[a]	1	.733	1.146	.303	.076	1.146	.170
	EFT_NEG	6.115[b]	1	6.115	2.238	.157	.138	2.238	.286
	EFT_POS	.074[c]	1	.074	.083	.778	.006	.083	.058
	EFT_NEUT	.002[d]	1	.002	.002	.967	.000	.002	.050
Intercept	**EFT_Score**	694.825	1	694.825	1086.663	.000	.987	1086.663	1.000
	EFT_NEG	659.055	1	659.055	241.180	.000	.945	241.180	1.000
	EFT_POS	872.834	1	872.834	977.133	.000	.986	977.133	1.000
	EFT_NEUT	554.192	1	554.192	483.650	.000	.972	483.650	1.000
AnxGroup	**EFT_Score**	.733	1	.733	1.146	.303	.076	1.146	.170
	EFT_NEG	6.115	1	6.115	2.238	.157	.138	2.238	.286
	EFT_POS	.074	1	.074	.083	.778	.006	.083	.058
	EFT_NEUT	.002	1	.002	.002	.967	.000	.002	.050

Error	**EFT_Score**	8.952	14	.639					
	EFT_NEG	38.257	14	2.733					
	EFT_POS	12.506	14	.893					
	EFT_NEUT	16.042	14	1.146					
Total	**EFT_Score**	762.912	16						
	EFT_NEG	781.630	16						
	EFT_POS	939.325	16						
	EFT_NEUT	607.750	16						
Corrected Total	**EFT_Score**	9.684	15						
	EFT_NEG	44.372	15						
	EFT_POS	12.579	15						
	EFT_NEUT	16.044	15						

EEG Mean Potential – P300 (275-325ms)

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power[g]**
Corrected Model	**LTempo**	345.367[a]	1	345.367	96.075	.010	.980	96.075	.991
	PFC	41.848[b]	1	41.848	4.402	.171	.688	4.402	.233
	RTempo	.282[c]	1	.282	.132	.751	.062	.132	.056
	Occipital	523.943[d]	1	523.943	34.747	.028	.946	34.747	.825
	RPosterior	16.357[e]	1	16.357	153.217	.006	.987	153.217	.999
	LPosterior	58.046[f]	1	58.046	55.046	.018	.965	55.046	.935
Intercept	**LTempo**	17.599	1	17.599	4.896	.157	.710	4.896	.252
	PFC	2.722	1	2.722	.286	.646	.125	.286	.063
	RTempo	583.593	1	583.593	273.814	.004	.993	273.814	1.000
	Occipital	78.235	1	78.235	5.188	.150	.722	5.188	.262
	RPosterior	224.402	1	224.402	2102.001	.000	.999	2102.001	1.000
	LPosterior	231.246	1	231.246	219.292	.005	.991	219.292	1.000
AnxietyGroup	**LTempo**	345.367	1	345.367	96.075	.010	.980	96.075	.991

	PFC	41.848	1	41.848	4.402	.171	.688	4.402	.233
	RTempo	.282	1	.282	.132	.751	.062	.132	.056
	Occipital	523.943	1	523.943	34.747	.028	.946	34.747	.825
	RPosterior	16.357	1	16.357	153.217	.006	.987	153.217	.999
	LPosterior	58.046	1	58.046	55.046	.018	.965	55.046	.935
Error	**LTempo**	7.190	2	3.595					
	PFC	19.015	2	9.507					
	RTempo	4.263	2	2.131					
	Occipital	30.158	2	15.079					
	RPosterior	.214	2	.107					
	LPosterior	2.109	2	1.055					
Total	**LTempo**	370.155	4						
	PFC	63.585	4						
	RTempo	588.138	4						
	Occipital	632.335	4						
	RPosterior	240.972	4						
	LPosterior	291.401	4						
Corrected Total	**LTempo**	352.556	3						

	PFC	60.863	3						
	RTempo	4.545	3						
	Occipital	554.100	3						
	RPosterior	16.570	3						
	LPosterior	60.155	3						

EEG Mean Potential – LPC (775-825ms) - ANOVA

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power[g]**
Corrected Model	**LTempo**	320.753[a]	1	320.753	137.977	.007	.986	137.977	.999
	PFC	118.010[b]	1	118.010	10.444	.084	.839	10.444	.429
	RTempo	.070[c]	1	.070	.013	.918	.007	.013	.051
	Occipital	701.239[d]	1	701.239	13.568	.066	.872	13.568	.510
	RPosterior	19.590[e]	1	19.590	.692	.493	.257	.692	.082
	LPosterior	44.086[f]	1	44.086	.974	.428	.328	.974	.094
Intercept	**LTempo**	55.053	1	55.053	23.682	.040	.922	23.682	.701
	PFC	4.119	1	4.119	.365	.607	.154	.365	.067
	RTempo	577.029	1	577.029	109.963	.009	.982	109.963	.996
	Occipital	16.148	1	16.148	.312	.632	.135	.312	.064
	RPosterior	231.600	1	231.600	8.185	.104	.804	8.185	.363
	LPosterior	275.043	1	275.043	6.077	.133	.752	6.077	.294
AnxietyGroup	**LTempo**	320.753	1	320.753	137.977	.007	.986	137.977	.999

	PFC	118.010	1	118.010	10.444	.084	.839	10.444	.429
	RTempo	.070	1	.070	.013	.918	.007	.013	.051
	Occipital	701.239	1	701.239	13.568	.066	.872	13.568	.510
	RPosterior	19.590	1	19.590	.692	.493	.257	.692	.082
	LPosterior	44.086	1	44.086	.974	.428	.328	.974	.094
Error	**LTempo**	4.649	2	2.325					
	PFC	22.598	2	11.299					
	RTempo	10.495	2	5.247					
	Occipital	103.367	2	51.683					
	RPosterior	56.589	2	28.294					
	LPosterior	90.518	2	45.259					
Total	**LTempo**	380.455	4						
	PFC	144.727	4						
	RTempo	587.595	4						
	Occipital	820.754	4						
	RPosterior	307.779	4						
	LPosterior	409.646	4						
Corrected Total	**LTempo**	325.402	3						

	PFC	140.608	3						
	RTempo	10.565	3						
	Occipital	804.605	3						
	RPosterior	76.179	3						
	LPosterior	134.603	3						

ANCOVA – (Variance of Anxiety Group – Variance of Valence) – P300 (275-325ms)

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[g]
Corrected Model	**LTempo**	349.094[a]	2	174.547	50.420	.099	.990	100.840	.386
	PFC	43.385[b]	2	21.692	1.241	.536	.713	2.482	.077
	RTempo	1.748[c]	2	.874	.313	.784	.385	.625	.058
	Occipital	542.020[d]	2	271.010	22.434	.148	.978	44.869	.265
	RPosterior	16.361[e]	2	8.181	39.091	.112	.987	78.182	.344
	LPosterior	60.141[f]	2	30.071	2083.088	.015	1.000	4166.177	.999
Intercept	**LTempo**	18.763	1	18.763	5.420	.258	.844	5.420	.145
	PFC	4.175	1	4.175	.239	.711	.193	.239	.056
	RTempo	263.277	1	263.277	94.149	.065	.989	94.149	.554
	Occipital	85.763	1	85.763	7.100	.229	.877	7.100	.166
	RPosterior	113.179	1	113.179	540.824	.027	.998	540.824	.932
	LPosterior	138.679	1	138.679	9606.734	.006	1.000	9606.734	1.000
Valence	**LTempo**	3.728	1	3.728	1.077	.488	.518	1.077	.075

	PFC	1.537	1	1.537	.088	.816	.081	.088	.052
	RTempo	1.466	1	1.466	.524	.601	.344	.524	.063
	Occipital	18.078	1	18.078	1.496	.436	.599	1.496	.083
	RPosterior	.004	1	.004	.020	.910	.020	.020	.051
	LPosterior	2.095	1	2.095	145.099	.053	.993	145.099	.655
AnxietyGroup	**LTempo**	345.367	1	345.367	99.763	.064	.990	99.763	.567
	PFC	41.848	1	41.848	2.394	.365	.705	2.394	.100
	RTempo	.282	1	.282	.101	.804	.092	.101	.052
	Occipital	523.943	1	523.943	43.372	.096	.977	43.372	.395
	RPosterior	16.357	1	16.357	78.161	.072	.987	78.161	.512
	LPosterior	58.046	1	58.046	4021.078	.010	1.000	4021.078	1.000
Error	**LTempo**	3.462	1	3.462					
	PFC	17.478	1	17.478					
	RTempo	2.796	1	2.796					
	Occipital	12.080	1	12.080					
	RPosterior	.209	1	.209					
	LPosterior	.014	1	.014					
Total	**LTempo**	370.155	4						

	PFC	63.585	4						
	RTempo	588.138	4						
	Occipital	632.335	4						
	RPosterior	240.972	4						
	LPosterior	291.401	4						
Corrected Total	**LTempo**	352.556	3						
	PFC	60.863	3						
	RTempo	4.545	3						
	Occipital	554.100	3						
	RPosterior	16.570	3						
	LPosterior	60.155	3						

ANCOVA – (Variance of Anxiety Group – Variance of Valence) – LPC (775-825ms)

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power[g]**
Corrected Model	**LTempo**	325.098[a]	2	162.549	533.828	.031	.999	1067.655	.898
	PFC	131.598[b]	2	65.799	7.303	.253	.936	14.605	.157
	RTempo	9.158[c]	2	4.579	3.255	.365	.867	6.510	.110
	Occipital	789.478[d]	2	394.739	26.094	.137	.981	52.189	.285
	RPosterior	36.323[e]	2	18.162	.456	.723	.477	.911	.061
	LPosterior	81.552[f]	2	40.776	.769	.628	.606	1.537	.068
Intercept	**LTempo**	45.165	1	45.165	148.327	.052	.993	148.327	.661
	PFC	16.335	1	16.335	1.813	.407	.644	1.813	.089
	RTempo	220.642	1	220.642	156.837	.051	.994	156.837	.674
	Occipital	89.942	1	89.942	5.946	.248	.856	5.946	.152
	RPosterior	186.418	1	186.418	4.677	.276	.824	4.677	.135
	LPosterior	257.768	1	257.768	4.859	.271	.829	4.859	.138
Valence	**LTempo**	4.345	1	4.345	14.269	.165	.935	14.269	.233
	PFC	13.588	1	13.588	1.508	.435	.601	1.508	.083

	RTempo	9.088	1	9.088	6.460	.239	.866	6.460	.158
	Occipital	88.239	1	88.239	5.833	.250	.854	5.833	.151
	RPosterior	16.733	1	16.733	.420	.634	.296	.420	.060
	LPosterior	37.467	1	37.467	.706	.555	.414	.706	.067
AnxietyGroup	**LTempo**	320.753	1	320.753	1053.386	.020	.999	1053.386	.989
	PFC	118.010	1	118.010	13.097	.172	.929	13.097	.224
	RTempo	.070	1	.070	.050	.860	.048	.050	.051
	Occipital	701.239	1	701.239	46.356	.093	.979	46.356	.407
	RPosterior	19.590	1	19.590	.492	.611	.330	.492	.062
	LPosterior	44.086	1	44.086	.831	.529	.454	.831	.069
Error	**LTempo**	.304	1	.304					
	PFC	9.010	1	9.010					
	RTempo	1.407	1	1.407					
	Occipital	15.127	1	15.127					
	RPosterior	39.856	1	39.856					
	LPosterior	53.051	1	53.051					
Total	**LTempo**	380.455	4						
	PFC	144.727	4						

	RTempo	587.595	4						
	Occipital	820.754	4						
	RPosterior	307.779	4						
	LPosterior	409.646	4						
Corrected Total	**LTempo**	325.402	3						
	PFC	140.608	3						
	RTempo	10.565	3						
	Occipital	804.605	3						
	RPosterior	76.179	3						
	LPosterior	134.603	3						

sLORETA Results – ANOVA – P300 (275-325ms)

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[aw]
Corrected Model	LBA08	.635[a]	1	.635	.215	.667	.051	.215	.065
	RBA08	.168[b]	1	.168	1.088	.356	.214	1.088	.129
	LBA09	.329[c]	1	.329	.982	.378	.197	.982	.121
	RBA09	.098[d]	1	.098	.094	.775	.023	.094	.057
	LBA10	.232[e]	1	.232	.075	.797	.018	.075	.055
	RBA10	.389[f]	1	.389	.141	.726	.034	.141	.060
	LBA11	1.989[g]	1	1.989	.133	.734	.032	.133	.059
	RBA11	.721[h]	1	.721	.026	.879	.007	.026	.052
	LBA13	.369[i]	1	.369	.049	.835	.012	.049	.054
	RBA13	.226[j]	1	.226	.044	.845	.011	.044	.053
	LBA21	.436[k]	1	.436	1.156	.343	.224	1.156	.134
	RBA21	.649[l]	1	.649	.244	.647	.057	.244	.067

LBA23	2.429[m]	1	2.429	21.517	.010	.843	21.517	.926
RBA23	1.536[n]	1	1.536	2.212	.211	.356	2.212	.211
LBA24	.085[o]	1	.085	.025	.881	.006	.025	.052
RBA24	.058[p]	1	.058	.015	.908	.004	.015	.051
LBA25	1.066[q]	1	1.066	.426	.549	.096	.426	.081
RBA25	2.073[r]	1	2.073	.136	.731	.033	.136	.060
LBA27	2.915[s]	1	2.915	.174	.698	.042	.174	.062
RBA27	6.490[t]	1	6.490	.152	.716	.037	.152	.061
LBA28	6.756[u]	1	6.756	2.795	.170	.411	2.795	.252
RBA28	2.496[v]	1	2.496	.267	.632	.063	.267	.069
LBA29	1.056[w]	1	1.056	.362	.580	.083	.362	.076
RBA29	1.491[x]	1	1.491	.682	.455	.146	.682	.099
LBA31	.417[y]	1	.417	.028	.875	.007	.028	.052
RBA31	.383[z]	1	.383	.035	.861	.009	.035	.052
LBA32	.088[aa]	1	.088	.065	.812	.016	.065	.055
RBA32	.032[ab]	1	.032	.022	.890	.005	.022	.052
LBA34	2.550[ac]	1	2.550	.878	.402	.180	.878	.113
RBA34	.939[ad]	1	.939	.232	.655	.055	.232	.067

LBA35	7.315[ae]	1	7.315	.494	.521	.110	.494	.085
RBA35	5.957[af]	1	5.957	.402	.561	.091	.402	.079
LBA36	7.498[ag]	1	7.498	1.087	.356	.214	1.087	.129
RBA36	3.697[ah]	1	3.697	.056	.824	.014	.056	.054
LBA38	3.882[ai]	1	3.882	.061	.818	.015	.061	.054
RBA38	1.331[aj]	1	1.331	.034	.863	.008	.034	.052
LBA41	.539[ak]	1	.539	.022	.890	.005	.022	.052
RBA41	.199[al]	1	.199	1.224	.331	.234	1.224	.139
LBA42	1.148[am]	1	1.148	.042	.848	.010	.042	.053
RBA42	.789[an]	1	.789	.459	.535	.103	.459	.083
LBA44	1.211[ao]	1	1.211	.027	.877	.007	.027	.052
RBA44	1.416[ap]	1	1.416	.255	.640	.060	.255	.068
LBA45	.984[aq]	1	.984	.193	.683	.046	.193	.064
RBA45	.814[ar]	1	.814	2.454	.192	.380	2.454	.228
LBA46	.470[as]	1	.470	.051	.833	.013	.051	.054
RBA46	.355[at]	1	.355	.047	.839	.012	.047	.053
LBA47	.923[au]	1	.923	.066	.809	.016	.066	.055
RBA47	1.119[av]	1	1.119	.041	.850	.010	.041	.053

Intercept	LBA08	1046.322	1	1046.322	354.177	.000	.989	354.177	1.000
	RBA08	606.150	1	606.150	3925.650	.000	.999	3925.650	1.000
	LBA09	600.920	1	600.920	1791.280	.000	.998	1791.280	1.000
	RBA09	260.787	1	260.787	249.342	.000	.984	249.342	1.000
	LBA10	673.593	1	673.593	219.114	.000	.982	219.114	1.000
	RBA10	620.044	1	620.044	225.263	.000	.983	225.263	1.000
	LBA11	1496.671	1	1496.671	99.968	.001	.962	99.968	1.000
	RBA11	1497.749	1	1497.749	54.712	.002	.932	54.712	.999
	LBA13	1062.308	1	1062.308	141.728	.000	.973	141.728	1.000
	RBA13	372.247	1	372.247	72.095	.001	.947	72.095	1.000
	LBA21	1074.556	1	1074.556	2847.907	.000	.999	2847.907	1.000
	RBA21	1905.457	1	1905.457	715.769	.000	.994	715.769	1.000
	LBA23	4267.429	1	4267.429	37796.489	.000	1.000	37796.489	1.000
	RBA23	2107.800	1	2107.800	3036.053	.000	.999	3036.053	1.000
	LBA24	466.558	1	466.558	139.619	.000	.972	139.619	1.000
	RBA24	328.305	1	328.305	85.656	.001	.955	85.656	1.000
	LBA25	2613.208	1	2613.208	1045.553	.000	.996	1045.553	1.000
	RBA25	2146.209	1	2146.209	140.882	.000	.972	140.882	1.000

LBA27	9943.621	1	9943.621	594.352	.000	.993	594.352	1.000
RBA27	1579.176	1	1579.176	37.015	.004	.902	37.015	.992
LBA28	20249.907	1	20249.907	8376.746	.000	1.000	8376.746	1.000
RBA28	7927.564	1	7927.564	848.994	.000	.995	848.994	1.000
LBA29	2394.947	1	2394.947	820.336	.000	.995	820.336	1.000
RBA29	1989.209	1	1989.209	909.164	.000	.996	909.164	1.000
LBA31	2184.450	1	2184.450	148.188	.000	.974	148.188	1.000
RBA31	1499.088	1	1499.088	135.510	.000	.971	135.510	1.000
LBA32	403.912	1	403.912	295.503	.000	.987	295.503	1.000
RBA32	267.486	1	267.486	183.543	.000	.979	183.543	1.000
LBA34	10732.762	1	10732.762	3693.984	.000	.999	3693.984	1.000
RBA34	2457.290	1	2457.290	606.864	.000	.993	606.864	1.000
LBA35	31795.138	1	31795.138	2148.810	.000	.998	2148.810	1.000
RBA35	4668.569	1	4668.569	314.965	.000	.987	314.965	1.000
LBA36	30271.097	1	30271.097	4388.615	.000	.999	4388.615	1.000
RBA36	10607.516	1	10607.516	160.973	.000	.976	160.973	1.000
LBA38	5301.317	1	5301.317	82.675	.001	.954	82.675	1.000
RBA38	6530.377	1	6530.377	165.337	.000	.976	165.337	1.000

	LBA41	1058.497	1	1058.497	42.413	.003	.914	42.413	.997
	RBA41	343.100	1	343.100	2114.963	.000	.998	2114.963	1.000
	LBA42	1242.455	1	1242.455	44.942	.003	.918	44.942	.998
	RBA42	1187.623	1	1187.623	691.031	.000	.994	691.031	1.000
	LBA44	1379.354	1	1379.354	31.196	.005	.886	31.196	.982
	RBA44	683.926	1	683.926	122.995	.000	.969	122.995	1.000
	LBA45	1530.824	1	1530.824	300.771	.000	.987	300.771	1.000
	RBA45	675.397	1	675.397	2036.096	.000	.998	2036.096	1.000
	LBA46	1479.863	1	1479.863	160.425	.000	.976	160.425	1.000
	RBA46	639.882	1	639.882	85.253	.001	.955	85.253	1.000
	LBA47	1173.361	1	1173.361	84.472	.001	.955	84.472	1.000
	RBA47	1747.029	1	1747.029	63.724	.001	.941	63.724	1.000
AnxietyGroup	LBA08	.635	1	.635	.215	.667	.051	.215	.065
	RBA08	.168	1	.168	1.088	.356	.214	1.088	.129
	LBA09	.329	1	.329	.982	.378	.197	.982	.121
	RBA09	.098	1	.098	.094	.775	.023	.094	.057
	LBA10	.232	1	.232	.075	.797	.018	.075	.055
	RBA10	.389	1	.389	.141	.726	.034	.141	.060

LBA11	1.989	1	1.989	.133	.734	.032	.133	.059
RBA11	.721	1	.721	.026	.879	.007	.026	.052
LBA13	.369	1	.369	.049	.835	.012	.049	.054
RBA13	.226	1	.226	.044	.845	.011	.044	.053
LBA21	.436	1	.436	1.156	.343	.224	1.156	.134
RBA21	.649	1	.649	.244	.647	.057	.244	.067
LBA23	2.429	1	2.429	21.517	.010	.843	21.517	.926
RBA23	1.536	1	1.536	2.212	.211	.356	2.212	.211
LBA24	.085	1	.085	.025	.881	.006	.025	.052
RBA24	.058	1	.058	.015	.908	.004	.015	.051
LBA25	1.066	1	1.066	.426	.549	.096	.426	.081
RBA25	2.073	1	2.073	.136	.731	.033	.136	.060
LBA27	2.915	1	2.915	.174	.698	.042	.174	.062
RBA27	6.490	1	6.490	.152	.716	.037	.152	.061
LBA28	6.756	1	6.756	2.795	.170	.411	2.795	.252
RBA28	2.496	1	2.496	.267	.632	.063	.267	.069
LBA29	1.056	1	1.056	.362	.580	.083	.362	.076
RBA29	1.491	1	1.491	.682	.455	.146	.682	.099

LBA31	.417	1	.417	.028	.875	.007	.028	.052
RBA31	.383	1	.383	.035	.861	.009	.035	.052
LBA32	.088	1	.088	.065	.812	.016	.065	.055
RBA32	.032	1	.032	.022	.890	.005	.022	.052
LBA34	2.550	1	2.550	.878	.402	.180	.878	.113
RBA34	.939	1	.939	.232	.655	.055	.232	.067
LBA35	7.315	1	7.315	.494	.521	.110	.494	.085
RBA35	5.957	1	5.957	.402	.561	.091	.402	.079
LBA36	7.498	1	7.498	1.087	.356	.214	1.087	.129
RBA36	3.697	1	3.697	.056	.824	.014	.056	.054
LBA38	3.882	1	3.882	.061	.818	.015	.061	.054
RBA38	1.331	1	1.331	.034	.863	.008	.034	.052
LBA41	.539	1	.539	.022	.890	.005	.022	.052
RBA41	.199	1	.199	1.224	.331	.234	1.224	.139
LBA42	1.148	1	1.148	.042	.848	.010	.042	.053
RBA42	.789	1	.789	.459	.535	.103	.459	.083
LBA44	1.211	1	1.211	.027	.877	.007	.027	.052
RBA44	1.416	1	1.416	.255	.640	.060	.255	.068

	LBA45	.984	1	.984	.193	.683	.046	.193	.064
	RBA45	.814	1	.814	2.454	.192	.380	2.454	.228
	LBA46	.470	1	.470	.051	.833	.013	.051	.054
	RBA46	.355	1	.355	.047	.839	.012	.047	.053
	LBA47	.923	1	.923	.066	.809	.016	.066	.055
	RBA47	1.119	1	1.119	.041	.850	.010	.041	.053
Error	LBA08	11.817	4	2.954					
	RBA08	.618	4	.154					
	LBA09	1.342	4	.335					
	RBA09	4.184	4	1.046					
	LBA10	12.297	4	3.074					
	RBA10	11.010	4	2.753					
	LBA11	59.886	4	14.971					
	RBA11	109.501	4	27.375					
	LBA13	29.982	4	7.495					
	RBA13	20.653	4	5.163					
	LBA21	1.509	4	.377					
	RBA21	10.648	4	2.662					

LBA23	.452	4	.113					
RBA23	2.777	4	.694					
LBA24	13.367	4	3.342					
RBA24	15.331	4	3.833					
LBA25	9.997	4	2.499					
RBA25	60.936	4	15.234					
LBA27	66.921	4	16.730					
RBA27	170.651	4	42.663					
LBA28	9.670	4	2.417					
RBA28	37.350	4	9.338					
LBA29	11.678	4	2.919					
RBA29	8.752	4	2.188					
LBA31	58.964	4	14.741					
RBA31	44.250	4	11.063					
LBA32	5.467	4	1.367					
RBA32	5.829	4	1.457					
LBA34	11.622	4	2.905					
RBA34	16.197	4	4.049					

LBA35	59.186	4	14.797					
RBA35	59.290	4	14.822					
LBA36	27.591	4	6.898					
RBA36	263.585	4	65.896					
LBA38	256.490	4	64.123					
RBA38	157.990	4	39.497					
LBA41	99.828	4	24.957					
RBA41	.649	4	.162					
LBA42	110.584	4	27.646					
RBA42	6.874	4	1.719					
LBA44	176.860	4	44.215					
RBA44	22.242	4	5.561					
LBA45	20.359	4	5.090					
RBA45	1.327	4	.332					
LBA46	36.899	4	9.225					
RBA46	30.023	4	7.506					
LBA47	55.562	4	13.890					
RBA47	109.663	4	27.416					

Total	LBA08	1058.774	6						
	RBA08	606.935	6						
	LBA09	602.591	6						
	RBA09	265.069	6						
	LBA10	686.122	6						
	RBA10	631.443	6						
	LBA11	1558.546	6						
	RBA11	1607.971	6						
	LBA13	1092.659	6						
	RBA13	393.126	6						
	LBA21	1076.501	6						
	RBA21	1916.755	6						
	LBA23	4270.310	6						
	RBA23	2112.113	6						
	LBA24	480.010	6						
	RBA24	343.693	6						
	LBA25	2624.271	6						
	RBA25	2209.219	6						

LBA27	10013.457	6						
RBA27	1756.317	6						
LBA28	20266.332	6						
RBA28	7967.410	6						
LBA29	2407.681	6						
RBA29	1999.452	6						
LBA31	2243.831	6						
RBA31	1543.722	6						
LBA32	409.468	6						
RBA32	273.347	6						
LBA34	10746.934	6						
RBA34	2474.426	6						
LBA35	31861.640	6						
RBA35	4733.815	6						
LBA36	30306.185	6						
RBA36	10874.799	6						
LBA38	5561.689	6						
RBA38	6689.698	6						

	LBA41	1158.864	6						
	RBA41	343.948	6						
	LBA42	1354.188	6						
	RBA42	1195.286	6						
	LBA44	1557.426	6						
	RBA44	707.584	6						
	LBA45	1552.166	6						
	RBA45	677.538	6						
	LBA46	1517.231	6						
	RBA46	670.260	6						
	LBA47	1229.846	6						
	RBA47	1857.811	6						
Corrected Total	LBA08	12.452	5						
	RBA08	.786	5						
	LBA09	1.671	5						
	RBA09	4.282	5						
	LBA10	12.528	5						
	RBA10	11.399	5						

	LBA11	61.875	5						
	RBA11	110.222	5						
	LBA13	30.351	5						
	RBA13	20.879	5						
	LBA21	1.945	5						
	RBA21	11.298	5						
	LBA23	2.881	5						
	RBA23	4.313	5						
	LBA24	13.452	5						
	RBA24	15.389	5						
	LBA25	11.063	5						
	RBA25	63.009	5						
	LBA27	69.836	5						
	RBA27	177.141	5						
	LBA28	16.425	5						
	RBA28	39.846	5						
	LBA29	12.734	5						
	RBA29	10.243	5						

	LBA31	59.381	5						
	RBA31	44.634	5						
	LBA32	5.556	5						
	RBA32	5.861	5						
	LBA34	14.172	5						
	RBA34	17.136	5						
	LBA35	66.502	5						
	RBA35	65.247	5						
	LBA36	35.089	5						
	RBA36	267.282	5						
	LBA38	260.372	5						
	RBA38	159.321	5						
	LBA41	100.367	5						
	RBA41	.847	5						
	LBA42	111.732	5						
	RBA42	7.663	5						
	LBA44	178.072	5						
	RBA44	23.659	5						

	LBA45	21.343	5						
	RBA45	2.141	5						
	LBA46	37.368	5						
	RBA46	30.378	5						
	LBA47	56.485	5						
	RBA47	110.782	5						

sLORETA Results - ANOVA – LPC (775-825ms)

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[aw]
Corrected Model	LBA08	.603[a]	1	.603	.278	.626	.065	.278	.070
	RBA08	.357[b]	1	.357	.111	.756	.027	.111	.058
	LBA09	.343[c]	1	.343	.078	.793	.019	.078	.056
	RBA09	.321[d]	1	.321	24.764	.008	.861	24.764	.953
	LBA10	1.323[e]	1	1.323	.392	.565	.089	.392	.078
	RBA10	.736[f]	1	.736	.131	.736	.032	.131	.059
	LBA11	1.355[g]	1	1.355	.095	.773	.023	.095	.057
	RBA11	.974[h]	1	.974	.036	.858	.009	.036	.053
	LBA13	.667[i]	1	.667	.083	.787	.020	.083	.056
	RBA13	.190[j]	1	.190	.038	.855	.009	.038	.053
	LBA21	.771[k]	1	.771	.997	.374	.200	.997	.122
	RBA21	.838[l]	1	.838	.145	.723	.035	.145	.060

LBA23	1.991[m]	1	1.991	.451	.539	.101	.451	.082
RBA23	1.073[n]	1	1.073	3.173	.149	.442	3.173	.279
LBA24	.282[o]	1	.282	.086	.783	.021	.086	.056
RBA24	.078[p]	1	.078	.028	.875	.007	.028	.052
LBA25	2.765[q]	1	2.765	4.696	.096	.540	4.696	.382
RBA25	3.010[r]	1	3.010	.147	.720	.036	.147	.061
LBA27	7.659[s]	1	7.659	.206	.674	.049	.206	.065
RBA27	2.734[t]	1	2.734	.072	.801	.018	.072	.055
LBA28	22.647[u]	1	22.647	1.612	.273	.287	1.612	.167
RBA28	6.163[v]	1	6.163	.314	.605	.073	.314	.072
LBA29	.712[w]	1	.712	.119	.748	.029	.119	.058
RBA29	.965[x]	1	.965	20.383	.011	.836	20.383	.914
LBA31	.224[y]	1	.224	.011	.923	.003	.011	.051
RBA31	.210[z]	1	.210	.015	.908	.004	.015	.051
LBA32	.059[aa]	1	.059	.031	.869	.008	.031	.052
RBA32	.051[ab]	1	.051	.028	.874	.007	.028	.052
LBA34	10.224[ac]	1	10.224	.734	.440	.155	.734	.103
RBA34	4.119[ad]	1	4.119	.400	.561	.091	.400	.079

LBA35	24.675[ae]	1	24.675	.390	.566	.089	.390	.078
RBA35	7.279[af]	1	7.279	.117	.749	.028	.117	.058
LBA36	21.703[ag]	1	21.703	.580	.489	.127	.580	.092
RBA36	2.713[ah]	1	2.713	.034	.863	.008	.034	.052
LBA38	6.374[ai]	1	6.374	.149	.720	.036	.149	.061
RBA38	2.864[aj]	1	2.864	.051	.832	.013	.051	.054
LBA41	.548[ak]	1	.548	.017	.903	.004	.017	.051
RBA41	.273[al]	1	.273	.250	.643	.059	.250	.068
LBA42	1.154[am]	1	1.154	.035	.861	.009	.035	.052
RBA42	.858[an]	1	.858	.192	.684	.046	.192	.064
LBA44	.784[ao]	1	.784	.016	.907	.004	.016	.051
RBA44	1.880[ap]	1	1.880	.432	.547	.098	.432	.081
LBA45	.968[aq]	1	.968	.062	.816	.015	.062	.054
RBA45	1.057[ar]	1	1.057	.361	.581	.083	.361	.076
LBA46	1.350[as]	1	1.350	.071	.803	.017	.071	.055
RBA46	1.342[at]	1	1.342	.115	.752	.028	.115	.058
LBA47	1.170[au]	1	1.170	.126	.741	.030	.126	.059
RBA47	1.078[av]	1	1.078	.042	.848	.010	.042	.053

Intercept	LBA08	1080.874	1	1080.874	499.041	.000	.992	499.041	1.000
	RBA08	642.606	1	642.606	199.479	.000	.980	199.479	1.000
	LBA09	618.587	1	618.587	141.226	.000	.972	141.226	1.000
	RBA09	275.608	1	275.608	21239.706	.000	1.000	21239.706	1.000
	LBA10	764.111	1	764.111	226.182	.000	.983	226.182	1.000
	RBA10	652.965	1	652.965	116.005	.000	.967	116.005	1.000
	LBA11	1497.966	1	1497.966	105.020	.001	.963	105.020	1.000
	RBA11	1497.199	1	1497.199	55.598	.002	.933	55.598	1.000
	LBA13	976.497	1	976.497	121.537	.000	.968	121.537	1.000
	RBA13	366.603	1	366.603	73.533	.001	.948	73.533	1.000
	LBA21	961.385	1	961.385	1242.879	.000	.997	1242.879	1.000
	RBA21	1716.845	1	1716.845	297.417	.000	.987	297.417	1.000
	LBA23	4229.548	1	4229.548	958.239	.000	.996	958.239	1.000
	RBA23	2106.983	1	2106.983	6231.889	.000	.999	6231.889	1.000
	LBA24	544.914	1	544.914	166.912	.000	.977	166.912	1.000
	RBA24	357.351	1	357.351	128.977	.000	.970	128.977	1.000
	LBA25	2114.839	1	2114.839	3592.242	.000	.999	3592.242	1.000
	RBA25	1853.442	1	1853.442	90.802	.001	.958	90.802	1.000

LBA27	8092.126	1	8092.126	217.457	.000	.982	217.457	1.000
RBA27	1539.670	1	1539.670	40.714	.003	.911	40.714	.996
LBA28	16096.747	1	16096.747	1145.557	.000	.997	1145.557	1.000
RBA28	6576.633	1	6576.633	334.812	.000	.988	334.812	1.000
LBA29	2326.708	1	2326.708	388.296	.000	.990	388.296	1.000
RBA29	2027.678	1	2027.678	42827.247	.000	1.000	42827.247	1.000
LBA31	2051.536	1	2051.536	96.905	.001	.960	96.905	1.000
RBA31	1485.324	1	1485.324	106.617	.000	.964	106.617	1.000
LBA32	438.948	1	438.948	230.962	.000	.983	230.962	1.000
RBA32	287.556	1	287.556	160.042	.000	.976	160.042	1.000
LBA34	8836.757	1	8836.757	634.056	.000	.994	634.056	1.000
RBA34	1987.662	1	1987.662	193.134	.000	.980	193.134	1.000
LBA35	27359.442	1	27359.442	432.874	.000	.991	432.874	1.000
RBA35	4143.032	1	4143.032	66.614	.001	.943	66.614	1.000
LBA36	26558.310	1	26558.310	710.209	.000	.994	710.209	1.000
RBA36	10223.768	1	10223.768	128.288	.000	.970	128.288	1.000
LBA38	4611.915	1	4611.915	107.521	.000	.964	107.521	1.000
RBA38	5527.731	1	5527.731	99.216	.001	.961	99.216	1.000

	LBA41	939.626	1	939.626	28.649	.006	.877	28.649	.973
	RBA41	333.601	1	333.601	305.408	.000	.987	305.408	1.000
	LBA42	1243.863	1	1243.863	37.324	.004	.903	37.324	.993
	RBA42	1152.307	1	1152.307	257.795	.000	.985	257.795	1.000
	LBA44	1434.652	1	1434.652	28.403	.006	.877	28.403	.972
	RBA44	524.530	1	524.530	120.615	.000	.968	120.615	1.000
	LBA45	1547.130	1	1547.130	98.351	.001	.961	98.351	1.000
	RBA45	552.424	1	552.424	188.388	.000	.979	188.388	1.000
	LBA46	1509.707	1	1509.707	79.307	.001	.952	79.307	1.000
	RBA46	648.694	1	648.694	55.529	.002	.933	55.529	1.000
	LBA47	1090.554	1	1090.554	117.036	.000	.967	117.036	1.000
	RBA47	1533.185	1	1533.185	59.313	.002	.937	59.313	1.000
AnxietyGroup	LBA08	.603	1	.603	.278	.626	.065	.278	.070
	RBA08	.357	1	.357	.111	.756	.027	.111	.058
	LBA09	.343	1	.343	.078	.793	.019	.078	.056
	RBA09	.321	1	.321	24.764	.008	.861	24.764	.953
	LBA10	1.323	1	1.323	.392	.565	.089	.392	.078
	RBA10	.736	1	.736	.131	.736	.032	.131	.059

LBA11	1.355	1	1.355	.095	.773	.023	.095	.057
RBA11	.974	1	.974	.036	.858	.009	.036	.053
LBA13	.667	1	.667	.083	.787	.020	.083	.056
RBA13	.190	1	.190	.038	.855	.009	.038	.053
LBA21	.771	1	.771	.997	.374	.200	.997	.122
RBA21	.838	1	.838	.145	.723	.035	.145	.060
LBA23	1.991	1	1.991	.451	.539	.101	.451	.082
RBA23	1.073	1	1.073	3.173	.149	.442	3.173	.279
LBA24	.282	1	.282	.086	.783	.021	.086	.056
RBA24	.078	1	.078	.028	.875	.007	.028	.052
LBA25	2.765	1	2.765	4.696	.096	.540	4.696	.382
RBA25	3.010	1	3.010	.147	.720	.036	.147	.061
LBA27	7.659	1	7.659	.206	.674	.049	.206	.065
RBA27	2.734	1	2.734	.072	.801	.018	.072	.055
LBA28	22.647	1	22.647	1.612	.273	.287	1.612	.167
RBA28	6.163	1	6.163	.314	.605	.073	.314	.072
LBA29	.712	1	.712	.119	.748	.029	.119	.058
RBA29	.965	1	.965	20.383	.011	.836	20.383	.914

LBA31	.224	1	.224	.011	.923	.003	.011	.051
RBA31	.210	1	.210	.015	.908	.004	.015	.051
LBA32	.059	1	.059	.031	.869	.008	.031	.052
RBA32	.051	1	.051	.028	.874	.007	.028	.052
LBA34	10.224	1	10.224	.734	.440	.155	.734	.103
RBA34	4.119	1	4.119	.400	.561	.091	.400	.079
LBA35	24.675	1	24.675	.390	.566	.089	.390	.078
RBA35	7.279	1	7.279	.117	.749	.028	.117	.058
LBA36	21.703	1	21.703	.580	.489	.127	.580	.092
RBA36	2.713	1	2.713	.034	.863	.008	.034	.052
LBA38	6.374	1	6.374	.149	.720	.036	.149	.061
RBA38	2.864	1	2.864	.051	.832	.013	.051	.054
LBA41	.548	1	.548	.017	.903	.004	.017	.051
RBA41	.273	1	.273	.250	.643	.059	.250	.068
LBA42	1.154	1	1.154	.035	.861	.009	.035	.052
RBA42	.858	1	.858	.192	.684	.046	.192	.064
LBA44	.784	1	.784	.016	.907	.004	.016	.051
RBA44	1.880	1	1.880	.432	.547	.098	.432	.081

	LBA45	.968	1	.968	.062	.816	.015	.062	.054
	RBA45	1.057	1	1.057	.361	.581	.083	.361	.076
	LBA46	1.350	1	1.350	.071	.803	.017	.071	.055
	RBA46	1.342	1	1.342	.115	.752	.028	.115	.058
	LBA47	1.170	1	1.170	.126	.741	.030	.126	.059
	RBA47	1.078	1	1.078	.042	.848	.010	.042	.053
Error	LBA08	8.664	4	2.166					
	RBA08	12.886	4	3.221					
	LBA09	17.520	4	4.380					
	RBA09	.052	4	.013					
	LBA10	13.513	4	3.378					
	RBA10	22.515	4	5.629					
	LBA11	57.054	4	14.264					
	RBA11	107.715	4	26.929					
	LBA13	32.138	4	8.035					
	RBA13	19.942	4	4.986					
	LBA21	3.094	4	.774					
	RBA21	23.090	4	5.773					

LBA23	17.656	4	4.414					
RBA23	1.352	4	.338					
LBA24	13.059	4	3.265					
RBA24	11.083	4	2.771					
LBA25	2.355	4	.589					
RBA25	81.647	4	20.412					
LBA27	148.850	4	37.213					
RBA27	151.267	4	37.817					
LBA28	56.206	4	14.051					
RBA28	78.571	4	19.643					
LBA29	23.968	4	5.992					
RBA29	.189	4	.047					
LBA31	84.682	4	21.171					
RBA31	55.725	4	13.931					
LBA32	7.602	4	1.901					
RBA32	7.187	4	1.797					
LBA34	55.747	4	13.937					
RBA34	41.166	4	10.292					

LBA35	252.817	4	63.204					
RBA35	248.778	4	62.195					
LBA36	149.580	4	37.395					
RBA36	318.775	4	79.694					
LBA38	171.573	4	42.893					
RBA38	222.857	4	55.714					
LBA41	131.190	4	32.797					
RBA41	4.369	4	1.092					
LBA42	133.304	4	33.326					
RBA42	17.879	4	4.470					
LBA44	202.043	4	50.511					
RBA44	17.395	4	4.349					
LBA45	62.923	4	15.731					
RBA45	11.730	4	2.932					
LBA46	76.145	4	19.036					
RBA46	46.728	4	11.682					
LBA47	37.272	4	9.318					
RBA47	103.396	4	25.849					

Total	LBA08	1090.140	6						
	RBA08	655.849	6						
	LBA09	636.450	6						
	RBA09	275.981	6						
	LBA10	778.947	6						
	RBA10	676.216	6						
	LBA11	1556.375	6						
	RBA11	1605.888	6						
	LBA13	1009.303	6						
	RBA13	386.735	6						
	LBA21	965.251	6						
	RBA21	1740.774	6						
	LBA23	4249.194	6						
	RBA23	2109.408	6						
	LBA24	558.255	6						
	RBA24	368.512	6						
	LBA25	2119.958	6						
	RBA25	1938.099	6						

LBA27	8248.635	6						
RBA27	1693.671	6						
LBA28	16175.599	6						
RBA28	6661.367	6						
LBA29	2351.389	6						
RBA29	2028.832	6						
LBA31	2136.442	6						
RBA31	1541.259	6						
LBA32	446.609	6						
RBA32	294.794	6						
LBA34	8902.728	6						
RBA34	2032.947	6						
LBA35	27636.934	6						
RBA35	4399.089	6						
LBA36	26729.594	6						
RBA36	10545.256	6						
LBA38	4789.862	6						
RBA38	5753.452	6						

	LBA41	1071.364	6						
	RBA41	338.244	6						
	LBA42	1378.321	6						
	RBA42	1171.044	6						
	LBA44	1637.478	6						
	RBA44	543.805	6						
	LBA45	1611.022	6						
	RBA45	565.211	6						
	LBA46	1587.202	6						
	RBA46	696.764	6						
	LBA47	1128.996	6						
	RBA47	1637.659	6						
Corrected Total	LBA08	9.266	5						
	RBA08	13.243	5						
	LBA09	17.864	5						
	RBA09	.373	5						
	LBA10	14.836	5						
	RBA10	23.251	5						

	LBA11	58.409	5						
	RBA11	108.689	5						
	LBA13	32.806	5						
	RBA13	20.132	5						
	LBA21	3.865	5						
	RBA21	23.928	5						
	LBA23	19.647	5						
	RBA23	2.425	5						
	LBA24	13.341	5						
	RBA24	11.161	5						
	LBA25	5.120	5						
	RBA25	84.658	5						
	LBA27	156.509	5						
	RBA27	154.001	5						
	LBA28	78.853	5						
	RBA28	84.734	5						
	LBA29	24.680	5						
	RBA29	1.154	5						

	LBA31	84.906	5						
	RBA31	55.935	5						
	LBA32	7.661	5						
	RBA32	7.238	5						
	LBA34	65.971	5						
	RBA34	45.285	5						
	LBA35	277.492	5						
	RBA35	256.057	5						
	LBA36	171.283	5						
	RBA36	321.488	5						
	LBA38	177.947	5						
	RBA38	225.721	5						
	LBA41	131.738	5						
	RBA41	4.643	5						
	LBA42	134.458	5						
	RBA42	18.738	5						
	LBA44	202.827	5						
	RBA44	19.275	5						

	LBA45	63.891	5						
	RBA45	12.787	5						
	LBA46	77.495	5						
	RBA46	48.070	5						
	LBA47	38.442	5						
	RBA47	104.474	5						

sLORETA Results – ANOVA – Negative EFT – LPC (775-825ms)

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[aw]
Corrected Model	LBA08	.129[a]	1	.129	.864	.451	.302	.864	.089
	RBA08	.124[b]	1	.124	18.028	.051	.900	18.028	.606
	LBA09	.314[c]	1	.314	.993	.424	.332	.993	.095
	RBA09	.129[d]	1	.129	.616	.515	.235	.616	.078
	LBA10	1.133[e]	1	1.133	3.033	.224	.603	3.033	.181
	RBA10	.209[f]	1	.209	3.537	.201	.639	3.537	.200
	LBA11	1.028[g]	1	1.028	5.246	.149	.724	5.246	.264
	RBA11	.642[h]	1	.642	1.001	.423	.333	1.001	.095
	LBA13	.101[i]	1	.101	.593	.522	.229	.593	.077
	RBA13	.292[j]	1	.292	23.198	.041	.921	23.198	.693
	LBA21	.451[k]	1	.451	.512	.548	.204	.512	.073
	RBA21	.648[l]	1	.648	306.148	.003	.994	306.148	1.000
	LBA23	1.180[m]	1	1.180	.826	.459	.292	.826	.088

RBA23	.700[n]	1	.700	.786	.469	.282	.786	.086
LBA24	.069[o]	1	.069	.712	.488	.262	.712	.082
RBA24	.036[p]	1	.036	1.563	.338	.439	1.563	.120
LBA25	.357[q]	1	.357	.171	.720	.079	.171	.058
RBA25	.609[r]	1	.609	3.337	.209	.625	3.337	.193
LBA27	2.712[s]	1	2.712	.195	.702	.089	.195	.059
RBA27	2.031[t]	1	2.031	7.608	.110	.792	7.608	.344
LBA28	5.411[u]	1	5.411	.153	.734	.071	.153	.057
RBA28	1.350[v]	1	1.350	.648	.505	.245	.648	.080
LBA29	.630[w]	1	.630	7.426	.112	.788	7.426	.339
RBA29	.788[x]	1	.788	.943	.434	.320	.943	.093
LBA31	.132[y]	1	.132	.203	.697	.092	.203	.059
RBA31	.133[z]	1	.133	.644	.507	.243	.644	.079
LBA32	.041[aa]	1	.041	.340	.619	.145	.340	.066
RBA32	.037[ab]	1	.037	.831	.458	.293	.831	.088
LBA34	2.709[ac]	1	2.709	.168	.721	.078	.168	.058
RBA34	.713[ad]	1	.713	3.027	.224	.602	3.027	.180
LBA35	7.874[ae]	1	7.874	.249	.667	.111	.249	.061

	RBA35	4.079[af]	1	4.079	6.373	.128	.761	6.373	.304
	LBA36	7.335[ag]	1	7.335	.328	.625	.141	.328	.065
	RBA36	2.617[ah]	1	2.617	5.976	.134	.749	5.976	.290
	LBA38	3.214[ai]	1	3.214	.540	.539	.213	.540	.075
	RBA38	.933[aj]	1	.933	1.056	.412	.346	1.056	.098
	LBA41	.331[ak]	1	.331	10.852	.081	.844	10.852	.440
	RBA41	.167[al]	1	.167	1.241	.381	.383	1.241	.106
	LBA42	.608[am]	1	.608	.634	.509	.241	.634	.079
	RBA42	.371[an]	1	.371	.675	.498	.252	.675	.081
	LBA44	.035[ao]	1	.035	8.568	.100	.811	8.568	.374
	RBA44	1.518[ap]	1	1.518	2.343	.265	.540	2.343	.153
	LBA45	.537[aq]	1	.537	5.727	.139	.741	5.727	.281
	RBA45	1.013[ar]	1	1.013	3.914	.186	.662	3.914	.215
	LBA46	.762[as]	1	.762	4.625	.164	.698	4.625	.242
	RBA46	.815[at]	1	.815	3.082	.221	.606	3.082	.183
	LBA47	1.036[au]	1	1.036	1.540	.340	.435	1.540	.119
	RBA47	1.058[av]	1	1.058	2.631	.246	.568	2.631	.164
Intercept	LBA08	531.489	1	531.489	3568.412	.000	.999	3568.412	1.000

RBA08	376.230	1	376.230	54805.561	.000	1.000	54805.561	1.000
LBA09	427.784	1	427.784	1354.581	.001	.999	1354.581	1.000
RBA09	195.152	1	195.152	930.084	.001	.998	930.084	1.000
LBA10	641.774	1	641.774	1718.201	.001	.999	1718.201	1.000
RBA10	298.804	1	298.804	5067.321	.000	1.000	5067.321	1.000
LBA11	1386.118	1	1386.118	7073.679	.000	1.000	7073.679	1.000
RBA11	1282.840	1	1282.840	1998.635	.000	.999	1998.635	1.000
LBA13	390.035	1	390.035	2291.991	.000	.999	2291.991	1.000
RBA13	434.197	1	434.197	34453.194	.000	1.000	34453.194	1.000
LBA21	685.701	1	685.701	778.553	.001	.997	778.553	1.000
RBA21	1550.674	1	1550.674	733135.932	.000	1.000	733135.932	1.000
LBA23	2595.943	1	2595.943	1818.519	.001	.999	1818.519	1.000
RBA23	1428.190	1	1428.190	1604.884	.001	.999	1604.884	1.000
LBA24	364.364	1	364.364	3742.517	.000	.999	3742.517	1.000
RBA24	239.277	1	239.277	10439.925	.000	1.000	10439.925	1.000
LBA25	1483.093	1	1483.093	709.297	.001	.997	709.297	1.000
RBA25	1795.454	1	1795.454	9833.530	.000	1.000	9833.530	1.000
LBA27	4519.476	1	4519.476	325.725	.003	.994	325.725	1.000

RBA27	1785.316	1	1785.316	6688.094	.000	1.000	6688.094	1.000
LBA28	11369.488	1	11369.488	320.853	.003	.994	320.853	1.000
RBA28	5413.545	1	5413.545	2597.449	.000	.999	2597.449	1.000
LBA29	1278.592	1	1278.592	15064.024	.000	1.000	15064.024	1.000
RBA29	1473.040	1	1473.040	1762.994	.001	.999	1762.994	1.000
LBA31	931.876	1	931.876	1436.697	.001	.999	1436.697	1.000
RBA31	735.052	1	735.052	3565.424	.000	.999	3565.424	1.000
LBA32	384.080	1	384.080	3165.784	.000	.999	3165.784	1.000
RBA32	255.192	1	255.192	5714.499	.000	1.000	5714.499	1.000
LBA34	5671.694	1	5671.694	352.091	.003	.994	352.091	1.000
RBA34	1766.164	1	1766.164	7496.601	.000	1.000	7496.601	1.000
LBA35	18815.581	1	18815.581	595.939	.002	.997	595.939	1.000
RBA35	3896.444	1	3896.444	6088.385	.000	1.000	6088.385	1.000
LBA36	18646.107	1	18646.107	833.406	.001	.998	833.406	1.000
RBA36	8935.486	1	8935.486	20403.708	.000	1.000	20403.708	1.000
LBA38	5429.833	1	5429.833	911.872	.001	.998	911.872	1.000
RBA38	5305.229	1	5305.229	6002.244	.000	1.000	6002.244	1.000
LBA41	306.336	1	306.336	10043.855	.000	1.000	10043.855	1.000

	RBA41	191.975	1	191.975	1428.599	.001	.999	1428.599	1.000
	LBA42	486.884	1	486.884	507.454	.002	.996	507.454	1.000
	RBA42	584.992	1	584.992	1065.791	.001	.998	1065.791	1.000
	LBA44	230.771	1	230.771	56235.960	.000	1.000	56235.960	1.000
	RBA44	605.209	1	605.209	934.155	.001	.998	934.155	1.000
	LBA45	738.470	1	738.470	7868.580	.000	1.000	7868.580	1.000
	RBA45	471.542	1	471.542	1822.173	.001	.999	1822.173	1.000
	LBA46	671.188	1	671.188	4075.605	.000	1.000	4075.605	1.000
	RBA46	298.691	1	298.691	1129.316	.001	.998	1129.316	1.000
	LBA47	1059.626	1	1059.626	1576.050	.001	.999	1576.050	1.000
	RBA47	1774.099	1	1774.099	4411.789	.000	1.000	4411.789	1.000
AnxietyGroup	LBA08	.129	1	.129	.864	.451	.302	.864	.089
	RBA08	.124	1	.124	18.028	.051	.900	18.028	.606
	LBA09	.314	1	.314	.993	.424	.332	.993	.095
	RBA09	.129	1	.129	.616	.515	.235	.616	.078
	LBA10	1.133	1	1.133	3.033	.224	.603	3.033	.181
	RBA10	.209	1	.209	3.537	.201	.639	3.537	.200
	LBA11	1.028	1	1.028	5.246	.149	.724	5.246	.264

RBA11	.642	1	.642	1.001	.423	.333	1.001	.095
LBA13	.101	1	.101	.593	.522	.229	.593	.077
RBA13	.292	1	.292	23.198	.041	.921	23.198	.693
LBA21	.451	1	.451	.512	.548	.204	.512	.073
RBA21	.648	1	.648	306.148	.003	.994	306.148	1.000
LBA23	1.180	1	1.180	.826	.459	.292	.826	.088
RBA23	.700	1	.700	.786	.469	.282	.786	.086
LBA24	.069	1	.069	.712	.488	.262	.712	.082
RBA24	.036	1	.036	1.563	.338	.439	1.563	.120
LBA25	.357	1	.357	.171	.720	.079	.171	.058
RBA25	.609	1	.609	3.337	.209	.625	3.337	.193
LBA27	2.712	1	2.712	.195	.702	.089	.195	.059
RBA27	2.031	1	2.031	7.608	.110	.792	7.608	.344
LBA28	5.411	1	5.411	.153	.734	.071	.153	.057
RBA28	1.350	1	1.350	.648	.505	.245	.648	.080
LBA29	.630	1	.630	7.426	.112	.788	7.426	.339
RBA29	.788	1	.788	.943	.434	.320	.943	.093
LBA31	.132	1	.132	.203	.697	.092	.203	.059

RBA31	.133	1	.133	.644	.507	.243	.644	.079
LBA32	.041	1	.041	.340	.619	.145	.340	.066
RBA32	.037	1	.037	.831	.458	.293	.831	.088
LBA34	2.709	1	2.709	.168	.721	.078	.168	.058
RBA34	.713	1	.713	3.027	.224	.602	3.027	.180
LBA35	7.874	1	7.874	.249	.667	.111	.249	.061
RBA35	4.079	1	4.079	6.373	.128	.761	6.373	.304
LBA36	7.335	1	7.335	.328	.625	.141	.328	.065
RBA36	2.617	1	2.617	5.976	.134	.749	5.976	.290
LBA38	3.214	1	3.214	.540	.539	.213	.540	.075
RBA38	.933	1	.933	1.056	.412	.346	1.056	.098
LBA41	.331	1	.331	10.852	.081	.844	10.852	.440
RBA41	.167	1	.167	1.241	.381	.383	1.241	.106
LBA42	.608	1	.608	.634	.509	.241	.634	.079
RBA42	.371	1	.371	.675	.498	.252	.675	.081
LBA44	.035	1	.035	8.568	.100	.811	8.568	.374
RBA44	1.518	1	1.518	2.343	.265	.540	2.343	.153
LBA45	.537	1	.537	5.727	.139	.741	5.727	.281

	RBA45	1.013	1	1.013	3.914	.186	.662	3.914	.215
	LBA46	.762	1	.762	4.625	.164	.698	4.625	.242
	RBA46	.815	1	.815	3.082	.221	.606	3.082	.183
	LBA47	1.036	1	1.036	1.540	.340	.435	1.540	.119
	RBA47	1.058	1	1.058	2.631	.246	.568	2.631	.164
Error	LBA08	.298	2	.149					
	RBA08	.014	2	.007					
	LBA09	.632	2	.316					
	RBA09	.420	2	.210					
	LBA10	.747	2	.374					
	RBA10	.118	2	.059					
	LBA11	.392	2	.196					
	RBA11	1.284	2	.642					
	LBA13	.340	2	.170					
	RBA13	.025	2	.013					
	LBA21	1.761	2	.881					
	RBA21	.004	2	.002					
	LBA23	2.855	2	1.428					

RBA23	1.780	2	.890					
LBA24	.195	2	.097					
RBA24	.046	2	.023					
LBA25	4.182	2	2.091					
RBA25	.365	2	.183					
LBA27	27.750	2	13.875					
RBA27	.534	2	.267					
LBA28	70.870	2	35.435					
RBA28	4.168	2	2.084					
LBA29	.170	2	.085					
RBA29	1.671	2	.836					
LBA31	1.297	2	.649					
RBA31	.412	2	.206					
LBA32	.243	2	.121					
RBA32	.089	2	.045					
LBA34	32.217	2	16.109					
RBA34	.471	2	.236					
LBA35	63.146	2	31.573					

	RBA35	1.280	2	.640					
	LBA36	44.747	2	22.373					
	RBA36	.876	2	.438					
	LBA38	11.909	2	5.955					
	RBA38	1.768	2	.884					
	LBA41	.061	2	.030					
	RBA41	.269	2	.134					
	LBA42	1.919	2	.959					
	RBA42	1.098	2	.549					
	LBA44	.008	2	.004					
	RBA44	1.296	2	.648					
	LBA45	.188	2	.094					
	RBA45	.518	2	.259					
	LBA46	.329	2	.165					
	RBA46	.529	2	.264					
	LBA47	1.345	2	.672					
	RBA47	.804	2	.402					
Total	LBA08	531.916	4						

RBA08	376.368	4						
LBA09	428.729	4						
RBA09	195.701	4						
LBA10	643.654	4						
RBA10	299.131	4						
LBA11	1387.537	4						
RBA11	1284.766	4						
LBA13	390.476	4						
RBA13	434.515	4						
LBA21	687.914	4						
RBA21	1551.326	4						
LBA23	2599.978	4						
RBA23	1430.669	4						
LBA24	364.628	4						
RBA24	239.358	4						
LBA25	1487.632	4						
RBA25	1796.429	4						
LBA27	4549.939	4						

RBA27	1787.881	4						
LBA28	11445.769	4						
RBA28	5419.064	4						
LBA29	1279.392	4						
RBA29	1475.499	4						
LBA31	933.305	4						
RBA31	735.597	4						
LBA32	384.364	4						
RBA32	255.319	4						
LBA34	5706.620	4						
RBA34	1767.348	4						
LBA35	18886.601	4						
RBA35	3901.802	4						
LBA36	18698.189	4						
RBA36	8938.979	4						
LBA38	5444.957	4						
RBA38	5307.930	4						
LBA41	306.728	4						

	RBA41	192.410	4						
	LBA42	489.411	4						
	RBA42	586.460	4						
	LBA44	230.815	4						
	RBA44	608.023	4						
	LBA45	739.195	4						
	RBA45	473.072	4						
	LBA46	672.279	4						
	RBA46	300.036	4						
	LBA47	1062.006	4						
	RBA47	1775.961	4						
Corrected Total	LBA08	.427	3						
	RBA08	.137	3						
	LBA09	.945	3						
	RBA09	.549	3						
	LBA10	1.880	3						
	RBA10	.327	3						
	LBA11	1.420	3						

	RBA11	1.926	3						
	LBA13	.441	3						
	RBA13	.318	3						
	LBA21	2.213	3						
	RBA21	.652	3						
	LBA23	4.035	3						
	RBA23	2.479	3						
	LBA24	.264	3						
	RBA24	.082	3						
	LBA25	4.539	3						
	RBA25	.975	3						
	LBA27	30.463	3						
	RBA27	2.565	3						
	LBA28	76.282	3						
	RBA28	5.518	3						
	LBA29	.800	3						
	RBA29	2.459	3						
	LBA31	1.429	3						

	RBA31	.545	3						
	LBA32	.284	3						
	RBA32	.126	3						
	LBA34	34.926	3						
	RBA34	1.184	3						
	LBA35	71.020	3						
	RBA35	5.359	3						
	LBA36	52.082	3						
	RBA36	3.493	3						
	LBA38	15.124	3						
	RBA38	2.701	3						
	LBA41	.392	3						
	RBA41	.436	3						
	LBA42	2.527	3						
	RBA42	1.468	3						
	LBA44	.043	3						
	RBA44	2.814	3						
	LBA45	.725	3						

	RBA45	1.530	3						
	LBA46	1.091	3						
	RBA46	1.344	3						
	LBA47	2.380	3						
	RBA47	1.862	3						