UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL AND HUMAN SCIENCES

School of Psychology

Volume 1 of 1

Investigating the Impact of Episodic Future Thinking on Anxiety and its Relationship to Episodic Memory

By

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Thesis for the degree of Doctor of Clinical Psychology

4th August 2017

Systematic Literature Review Word Count: 11,317 (without tables or figures)

Empirical Paper Word Count: 11,089 (without tables or figures)

Total Word Count: 22,406

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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INVESTIGATING THE IMPACT OF EPISODIC FUTURE THINKING ON ANXIETY AND ITS RELATIONSHIP TO EPISODIC MEMORY

Georgina Isabel Bailey Knott

Episodic Future Thinking (EFT) is the ability to imagine oneself experiencing events in the future (Atance and O'Neill, 2001). This cognitive ability is often referred to as future Mental Time Travel (MTT) (Berntsen & Jacobsen, 2008). The first part of this thesis is a systematic review and narrative synthesis of 16 papers that critically evaluates the relationship between EFT and measures of anxiety. Interest in this topic was generated from the theoretical and clinical accounts of anxiety that make reference to the expectation of future life events. Whilst there is not consensus across the papers, the review indicates some preliminary support in favour of a positive correlation between anxiety and frequency of EFT. It also discusses results that suggest how anxiety is associated with EFT that has abstract and negative content. Consideration for the clinical implications of the findings are also reviewed.

The second part of this thesis is an empirical paper that investigates whether there is a direct relationship between the recall of episodic memory (past MTT) and the ability to engage in EFT (future MTT). It also examines whether deficits in MTT can be explained by an impaired search and retrieval strategy, as opposed to fragmented scene representation. Two female patients with focal hippocampal damage and documented autobiographical memory impairment, were asked to describe six events from their past and imagine six events they could potentially experience in their future. The Galton-Crovitz-Schiffman cue-word technique (Crovitz-Schiffman, 1974; Galton, 1879) was used to generate event descriptions. The patients were then prompted to elaborate on their descriptions using a pre-determined list of questions. The level of detail in their unprompted and prompted descriptions of past and future events was compared with five

age-matched neurotypical controls. The empirical paper presents two preliminary findings. Firstly, that scaffolding, in the provision of verbal cues assisted both patients to provide more detail for their past events. Secondly, that there may be a dissociation between the two directions of MTT; one of the patients displayed a strong trend towards a selective deficit in her prompted future descriptions.

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DECLARATION OF AUTHORSHIP

I, GEORGINA ISABEL BAILEY KNOTT, declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

INVESTIGATING THE IMPACT OF EPISODIC FUTRE THINKING ON ANXIETY AND ITS RELATIONSHIP TO EPISODIC MEMORY

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

Signed:

Date: 4th August 2017

Acknowledgements

I would like to thank all of the participants who generously gave their time to take part in the study and who continue to support research into memory.

This study would not have been possible without the guidance, patience and support of my supervisor Professor Rosaleen McCarthy; thank you for being an inspirational mentor during the last three years. I am also grateful to my university supervisor, Professor Nick Donnelly for providing assistance with the statistics. I wish to thank my course mentor Dr Nigel North for his encouragement and wisdom, and Dr Matt Garner for overseeing the project.

I would like to take this opportunity to acknowledge Dr Christopher Kipps, Lesley Mackinnon and Angus Prosser from the Young Onset Dementia Assessment (YODA) team, who supported this study as a sub-study to their much larger project and who helped me navigate my way through the ethics application. I would also like to thank the Neuropsychology department's assistants Nathaniel Rookes and Lewys Jones who accompanied me during home visits as well as Kate Wade-Brown and Eric Dixon for their assistance with preparing the data. I could not have completed the final writing stages without the input of Dr Ian Frampton, Dr Mark Foster, Dr Christy Pitfield and Dr Sophie Hughes, whose academic eyes and feedback provided invaluable support.

On a personal note, I would like to thank Professor Susan Greenfield for introducing me to the world of neuroscience. I thank my mother, Isabel, for inspiring my lifelong interest into time travel and my father, Michael, who has had the patience to read and provide feedback for every single assignment leading up to this; his pocket money allowance is still being negotiated! I also wish to extend my love and gratitude to my cohort who provided unwavering support at every step of this journey, as well as Sakura for being a constant calming companion.

I dedicate this work to my wonderful godchildren who give joy to my past, present and future and most importantly to my abuelo Grampus, for always being my greatest cheerleader and never doubting that I would one day become a doctor.

Chapter 1: Systematic Literature Review

1.1 Introduction

"Our anxiety does not come from thinking about the future, but from wanting to control it." (Gibran, 1923)

Episodic Future Thinking (EFT) is the ability to imagine oneself experiencing events in the future. This prospection involves more than just thinking about a future self; it is the mental simulation of possible future scenarios incorporating sensory information to generate thoughts, emotions and behaviour (Gilbert & Wilson, 2007). Humans frequently engage in this active and passive cognitive process, as it serves a number of purposes (D'Argembeau, Renaud & Van der Linden, 2011; Rubin & Berntsen, 2009). It has been reported that the majority of EFT contains emotional detail (D'Argembeau et al., 2011) which has generated interest into researching how positive and negative emotions can initiate and influence mentally simulated future events (Szpunar, Addis & Schacter, 2012).

Anxiety is usually classified as a negative emotion, although arguably such a perspective overlooks the importance of this primary affective state (Ekman, 1992). Anxiety has been defined as an intense, excessive and persistent sense of apprehension, fear and helplessness (Suárez, Bennett, Goldstein & Barlow, 2009). This feeling is usually accompanied by physiological symptoms which can include nausea, increased heart rate and shakiness that many people find distressing (Kirmayer, 2001). These cognitive and physical symptoms often result in people changing their behaviour and avoiding situations that trigger these responses; these can have a debilitating impact on an individual's quality of life. A recent survey reported that 8.2 million people in the United Kingdom have experienced symptoms of anxiety that have led them to seek professional support (Fineberg et al., 2013).

Since theoretical and clinical accounts of anxiety make reference to the expectation of future life events, it suggests that there is a relationship between EFT and anxiety. This literature review, therefore, focuses on how EFT and measures of anxiety are related to one another. It also considers how knowledge gained from the literature can assist with the development of new therapeutic interventions. This combination is novel in so far as this topic as it has not been directly addressed in previous published reviews.

1.1.1 The Origin of Episodic Future Thinking

Episodic future thinking has its conceptual roots in episodic memory (Atance & O'Neill, 2001). The latter involves the reliving of behavioural, sensory and emotional details of past personal experiences within a temporal and spatial context (Dickerson & Eichenbaum, 2010). A key attribute of this type of memory is the sense of re-living an event (Tulving, 1993). This distinguishes it from autobiographical memory, which includes knowledge about ourselves that we know but cannot re-live, for example our birth. Tulving (1985) postulated that it is the combination of episodic memory with autonoetic consciousness, which is an individual's awareness of their existence and identity in time that allows people to time travel in their minds.

Chronesthesia, more frequently referred to as mental time travel (MTT), is the ability to mentally project oneself forwards and backwards in time (Suddendorf & Corballis, 1997; Tulving, 2002). Individuals can initiate MTT voluntarily by actively engaging in recalling an event from their past or imagining an event they believe they could experience in their future (Berntsen & Jacobsen, 2008). Mental time travel can also occur passively and spontaneously, for example as part of daydreaming.

It is proposed that approximately 1.5 million years ago, the ancestors of modern humans developed executive functioning skills that allowed them to detach mentally from present perceptions (Suddendorf & Corballis, 1997) and engage in MTT. However, more

recently research has challenged the notion that MTT is a process unique to humans, with emerging evidence to suggest that other primates (chimpanzees, orangutans, great apes) and some social species of birds may also possess this cognitive capability (Clayton, Bussey & Dickinson, 2003; Martin-Ordas, Haun, Colmenares & Call, 2010; Osvath, 2010).

Atance and O'Neill (2001) coined the term Episodic Future Thinking (EFT) to conceptualise future MTT. They describe it as "a projection of the self into the future to pre-experience an event" (p.533). Like episodic memory, EFT involves the consideration of oneself within a temporal and spatial context (Quoidbach, Wood & Hansenne, 2009). This autonoetic consciousness creates the sense of pre-living an experience, distinguishing between merely thinking about oneself in the future and EFT. It might seem that individuals spend more time thinking about their present circumstances rather than considering possible future events. However, it appears that a substantial amount of daily cognitive activity is allocated to EFT (Tonn, Hemrick & Conrad, 2006).

There is accumulating evidence supporting the hypothesis that episodic memory and EFT share similar neural and cognitive processes, with the content and specificity of past and future MTT being closely correlated (Maccallum & Bryant, 2011; Schacter, Addis & Buckner, 2007). Despite recent interest in EFT, there remains an ongoing debate and uncertainty about its exact function, helpfulness and meaning. An emerging and influential theory is that the primary role of MTT is to imagine and prepare for the future (Schacter & Addis, 2007; Schacter, et al., 2007). This premise stems from evolutionary theory (Darwin, 1859). Suddendorf (1999) suggested that EFT enabled ancestors of modern humans to gain an adaptive evolutionary advantage. Episodic future thinking can reduce the likelihood of impulsive and irresponsible behaviours (Quoidbach et al., 2009). The ability to mentally experience oneself in a variety of possible future scenarios allows for risk assessment and strategic planning of behaviours in the pursuit of long term goals, specifically survival and procreation (Suddendorf & Corballis, 2007). The cognitive

flexibility, creativity and problem solving skills that underpin EFT allow humans to not just survive, but thrive amidst a hostile and precarious environment (Schacter, 2012; Szpunar, 2010). Therefore, it is argued that EFT is a vital psychological construct that is fundamental to human experience (Gilbert & Wilson, 2007; Suddendorf & Corballis, 2007).

1.1.2 Episodic Future Thinking and Psychological Wellbeing

It is proposed that another function for EFT is that it potentially provides the foundations for optimal emotional wellbeing through the pursuit of happiness and enhancing interpersonal relationships. Research suggests how imagining experiencing events in the future can enhance motivation by increasing the likelihood of successful personal outcomes (Pham & Taylor, 1999; Vasquez & Buehler, 2007). MacLeod and Conway (2005) elaborate on this, reporting a positive correlation between individuals who engage in optimistic thinking about their future and subjective measures of happiness. Berntsen and Bohn (2010) identified a general bias towards imagining positive future experiences, i.e. those that involved pre-experiencing desired future events. Walker and Skowronkski (2009) propose that EFT with optimistic content enables people to maintain or improve a positive self-image, a pre-requisite for mental wellbeing. However, this positivity bias appears to be less prominent in people with anxiety and depression (MacLeod & Byrne, 1996).

King and Smith (2004) suggest that the positive effect of EFT is related to its tangibility. McElwee and Haugh (2010) expand on this concept by proposing the term "psychological realness" (p.300), which occurs when clarity, frequency, detail and accessibility of an event co-exist. Each of these elements are independent of one another, with individual differences in personality traits influencing their quality (King & Smith, 2004; McElwee & Haugh, 2010). When any one of these elements is lacking,

psychological realness may be compromised, which could lead to a distortion in EFT. This in turn may have a negative impact on mental wellbeing and contribute to low mood and anxiety (McElwee & Haugh, 2010).

One of the ways EFT may influence mood is through thought content. The cognitive content-specificity hypothesis, stemming from Beck's cognitive theory (Beck, 1976), proposes that the content of an individual's thoughts and appraisals are integral to the development and maintenance of emotional disorders. For example, the cognitive profile of depression reflects a theme of negative self-evaluation; a sense of loss, failure, hopelessness and pessimism transcending past, present and future thinking (Clark, Beck & Brown, 1989). In contrast, the cognitive content of anxiety focuses on physical or psychosocial threat, danger and harm. Individuals overestimate the chance of encountering situations that compromise personal safety and underestimate personal coping strategies (Beck, 1976). These cognitions appear to be more biased towards the future (Tellegen, 1985) with intolerance to uncertainty for future events being a core feature of anxiety (Dugas, Gagnon, Ladouceur & Freeston, 1998). Although depression and anxiety share a maladaptive attributional style with an increased tendency to anticipate experiencing negative events in the future, it is proposed that the content and frequency of these thoughts differ in EFT (McElwee & Haugh, 2010).

Clark and Watson (1991) proposed that anxiety and depression also share high levels of negative affect (NA). Negative affect is a "measure of unpleasurable engagement" in emotional states which include anger, fear and disgust (MacLeod, Tata, Kentish & Jacobsen, 1997, p.468). It is proposed that depression is uniquely characterised by low levels of positive affect (PA) (Clark & Watson, 1991). Positive affect is an orthogonal dimension relating to pleasurable emotional experiences, incorporating enthusiasm, happiness and engagement (Macleod et al., 1997). The bi-directional relationship between cognition and affect suggests that high levels of NA contribute to the

anticipation of negative events (Clark, Beck & Stewart, 1990). It would also suggest that low levels of PA contribute to reduced expectations of positive events. As anxiety is not associated with low PA (Clark et al., 1990), it is anticipated that anxious individuals would not experience a reduction in anticipating positive future events.

1.1.3 Exploring the Interaction between Episodic Future Thinking and Anxiety

In line with evolutionary theory, Mogg and Bradley (1998) propose that the ultimate function of anxiety is to identify potential threats to survival and consider scenarios that will prevent possible disasters from occurring. When an individual transitions from contemplation to mental simulation of potential events, they are engaging in EFT (Gilbert & Wilson, 2007). Mogg and Bradley (1998) opine that individuals experiencing clinical levels of anxiety have an overly heightened sensitivity to detecting risk. From this perspective, anxiety could be viewed as the catalyst to EFT. However, it may be that the emergence of MTT, and specifically EFT, that led humans to experience anxiety as a consequence of constructing threat related future scenarios (Miloyan, Bulley and Suddendorf, 2016).

To improve understanding of the interaction between EFT and anxiety, it is necessary to understand the fundamental qualities of anxiety. Anxiety is an emotional response to a cognitively perceived threat. It is characterised by heightened physiological arousal and typically results in avoidant behaviours motivated by an individual's survival instinct (Barlow, 2000). Anxiety is considered to manifest itself in two ways. State anxiety is regarded as a transient, contingent condition. It is the unpleasant emotional arousal triggered by stimuli that is perceived as threatening. Trait anxiety reflects relatively stable individual differences in the tendency to experience state anxiety (Speilberger, Gorsuch, Lushene, Vagg & Jacobs, 1983).

Whilst worry is a term that is often used interchangeably with anxiety, doing so overlooks important distinctions within their respective meanings. Applying Damasio's Somatic Marker Hypothesis (2008), 'anxiety' describes the physiological responses in the body to an internal or external stimulus that are relayed and interpreted by the brain. Conversely, 'worry' is a representational schema in the brain with a linguistic label, linked to specific thought content. Worrying can be understood as a mental behaviour; the meta-cognitive expression of the state of the body in the brain (Damasio, 2008; Wells, 1995). Consequently, worry cannot exist in isolation from anxiety, but is an integral component (Muris, Roelofs, Rassin, Franken & Mayer, 2005). Worry, as a state, can take the form of frequent consideration of the same thoughts and images. To that extent, it is similar to rumination. However, worry is considered a less passive and more negative cognitive process that is primarily anticipatory in nature (Hoyer, Gloster & Herzberg, 2009). Worry tends to focus on future scenarios that are perceived as presenting a possible physical or social threat (Matthews & Funke, 2006). Worry, as a trait, is an individual's general tendency to experience worry, that often occurs automatically and uncontrollably (Hallion, Ruscio & Jha, 2014). There are considerable individual differences in the propensity to worry. Ruscio, Borkovec and Ruscio (2001) suggest that worry is not a categorical construct, proposing that it is best understood as a trait existing on a spectrum with normal and pathological extremes. In the non-clinical population, worry appears to be closely linked to the personality trait neuroticism (Jyihä & Isometsä, 2006).

The most frequently reported topic of worry is interpersonal concerns; specifically, how individuals believe others perceive them (Roemer, Molina & Borkovec, 1997). Experiencing frequent, persistent, uncontrollable worry which impact on the ability to do desired daily activities is at the core of all anxiety disorders. However, it is most emphasised in the diagnostic criteria for Generalised Anxiety Disorder (GAD; American Psychiatric Association, 2013).

One of the most prominent theories of worry is The Cognitive Avoidance theory (Borkovec, Robinson, Pruzinsky & DuPree, 1983). This postulates that the function of worry is cognitive avoidance, which involves disengagement from negative thoughts. This serves the purpose of reducing physiological arousal (Sibrava & Borkovec, 2006). Although worrying may temporarily reduce anxiety, it prevents necessary emotional processing and sustains anxious cognitions.

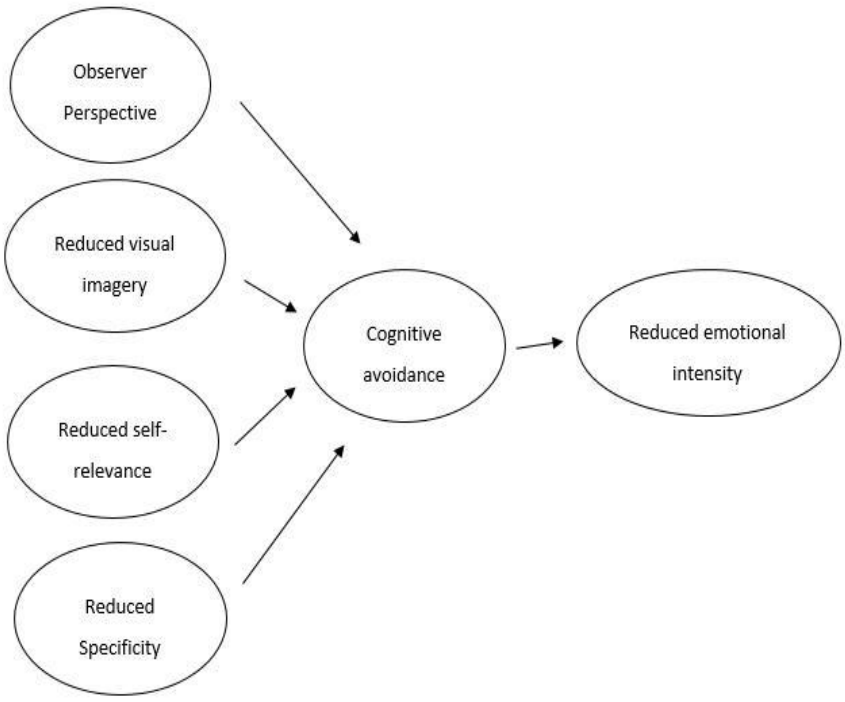

Figure 1. Cognitive avoidance model. As depicted by Finnbogadóttir and Berntsen (2011)

Individuals who worry frequently report that one of their motivations is to distract themselves from more distressing subjects (Borkovec & Roemer, 1995). Stöber (1998) expands on the cognitive avoidance theory by proposing the reduced concreteness theory of worry. This suggests that the nature of worry is predominantly verbal and abstract, resulting in fewer visual images. Studies supporting this observe a shift in the content of thoughts becoming more verbal when participants engage in worry after a period of relaxation (Freeston, Dugas & Ladoceur, 1996).

According to Stöber (1998) abstract cognitions are those that are "indistinct, cross-situational, equivocal, unclear and aggregated". Abstract cognitions give individuals a means to avoid engaging in fear provoking imagery. This appears to result in reduced physiological arousal and emotion. Stöber (1998) proposes that it is this linguistic and less concrete thought process that is the basis of cognitive avoidance. Concrete future cognitions have an adaptive advantage of developing and rehearsing problem-solving strategies. Abstract thinking is maladaptive as it inhibits these important mental processes.

Liberman and Trope (1998) discuss construal level theory and how the temporal distance of an event can influence its mental representation. Events in the more distant future are associated with more abstract, less specific and decontextualised qualities (Fortunato & Furey, 2011). Combining construal level theory with other theories of anxiety suggests that individuals who regularly engage in more distant EFT are more likely to experience anxiety. However, according to Fortunato and Furey's MindTime theory (2009), individuals with a tendency to form abstract mental representations as a result of their distal future temporal perspective are more likely to think creatively and optimistically. Given the increasing evidence base that optimism can act as an antidote to anxiety (Dolcos, Hu, Iordan, Moore and Dolcos, 2015), the MindTime theory could be extrapolated to suggest that such abstract optimistic EFT may in fact reduce anxiety.

A review by Behar, DiMarco, Hekler, Mohlman & Staples (2009) discusses the role of verbal-linguistic programming to reduce possible simulation of feared future events as a key element in understanding worry and anxiety. This theory could imply that anxious individuals may experience EFT with less clarity, fluidity and autonomic arousal than people without anxiety. Zaleski (1996) proposes that greater clarity imagining oneself experiencing the future may reduce anxiety because there is less perceived uncertainty. Alternatively, it may be that anxious individuals experience EFT with less vivid visual and

other sensory imagery in order to reduce their affect (D'Argembeau & Van der Linden, 2006).

It is also possible that anxious individuals attempt to disengage from the emotional intensity of negative content in EFT by imagining the event from another person's perspective (Berntsen & Rubin, 2006). In that case, it poses the question as to whether these individuals are truly engaging in EFT; this personal avoidance is likely to be reducing their crucial sense of pre-living an event, which distinguishes EFT from imagining the future. According to the cognitive appraisal theory of emotion (Lazarus, 1982) self-relevance is a fundamental attribute to emotion. Experiencing EFT from a less personally significant stance could be another approach that anxious individuals subconsciously adopt in order to inhibit intense emotion (Berntsen & Rubin, 2006).

1.1.4 Clinical Implications for Understanding the Relationship between Episodic Future Thinking and Anxiety

Developing psychological treatments that consider how individuals think about themselves in the future are likely to have considerable therapeutic potential. At the crux of Cognitive Behaviour Therapy (CBT) is the process of changing thoughts about oneself so as to alter emotional and physical experiences and individual behaviours (Beck, Rush, Shaw & Emery, 1979). Third wave CBT based treatments have evolved to focus on changing the relationship individuals have with their thoughts (Kahl, Winter & Schweiger, 2012). One of these treatments is mindfulness practice, which encourages individuals to bring awareness to the present moment with openness, curiosity and flexibility (Harris, 2008; Kabat-Zin, 1994). Consequently, individuals engage less in MTT. There is increasing evidence that mindfulness reduces both symptoms of depression and anxiety (Desrosiers, Vine, Klemanski & Nolen-Hoeksema, 2013; Hofmann, Sawyer, Witt & Oh, 2010). Desrosiers and colleagues (2013) propose that the effectiveness of mindfulness is

due to its present focused orientation, which prevents the mind from engaging in rumination of past troubles or worrying about future problems. Therefore, it follows that being naturally mindful or practicing mindfulness regularly can lead to reduced anxiety (Delgado et al, 2010; Robins, Keng, Ekblad & Brantley, 2011).

Given the overlap between the thoughts and emotions underpinning depression and anxiety, it is not uncommon for these conditions to co-exist in at least 50% of primary care presentations (Hirschfeld, 2001). Recent research has concentrated on differentiating anxiety and depression profiles to assist with developing new treatment interventions. Episodic future thinking appears to be an area where there are distinct cognitive and affective differences between depressed and anxious individuals. The decision for this literature review solely to focus on anxiety measures was driven by the current weighting of published literature already addressing the relationship between EFT and measures of depression (Miloyan, Pachana & Suddendorf, 2014).

1.1.5 Summary of the Literature

There still appears to be much to be learnt about the relationship between EFT and anxiety. Research literature presents a paradox; on the one hand EFT is considered a positive cognitive process, necessary for motivation, planning and creativity (Vasquez & Buehler, 2007). On the other hand, there is evidence suggesting that it can exacerbate worry and contribute to anxiety (Mogg & Bradley, 1998). A more detailed understanding of the elements involved with EFT may explain this contradiction. The fundamental question is whether anxious individuals experience EFT differently in terms of frequency, clarity, plausibility, valence and temporal distance. Currently, it is unclear as to whether the process of worry enhances or impedes the ability to engage with EFT. Anxious individuals appear to perceive the future more pessimistically (MacLeod & Byrne, 1996). Therefore, it would seem logical to predict that anxious individuals would not only have a

bias towards negative EFT, but that they will believe that these negative future events are more likely to occur.

Cognitive avoidance theory (Borkovec et al., 1983) and the theory of reduced concreteness Stöber (1998) suggest that anxious individuals may have reduced imagery in their EFT. In a bid to reduce emotional intensity, EFT may also be less specific, vivid, personally relevant, and described from an observer perspective. The construal level theory (Liberman & Trope, 1998) suggests a hypothesis that anxiety may also increase the likelihood of temporally distant EFT. This complements other theories that support any factor allowing for less vivid and tangible EFT as a means of avoiding anxiety. However, it may be that abstract EFT reduces anxiety through increasing optimism, in line with MindTime theory (Fortunato & Furey, 2009).

1.1.6 Aim of the Literature Review

This literature review focuses on examining the relationship between EFT and anxiety. It critically evaluates the current findings and discusses the clinical implications. Specifically, it will explore whether experiencing anxiety (ascertained through subjective dimensional measures and/or clinical assessment) affects how individuals experience EFT.

1.1.7 Hypotheses

1. Individuals with higher measures of anxiety will engage in EFT more frequently than individuals with lower measures of anxiety.
2. Individuals with higher measures of anxiety will report experiencing more negative content, but no difference in the amount of positive content in their EFT, when compared with individuals with lower measures of anxiety.

3. Individuals with higher measures of anxiety and/or worry will experience more abstract EFT; specifically their EFT will contain less imagery and specific detail, and be more temporally distant than individuals with lower levels of worry
4. Individuals with higher measures of anxiety will engage in less self-relevant EFT than individuals with lower measures of anxiety.

1.2 Method

The methodology of a systematic literature review was selected. This allowed for the identification and evaluation of studies that use a "strict scientific design based on explicit, pre-specified and reproducible methods (Centre for Reviews and Dissemination, 2009, p.5).

1.2.1 Search Strategy

Episodic future thinking is a topic of interest that transcends the field of psychology into other related disciplines. Therefore, the search strategy included Web of Science, Psychinfo and MedLine databases. These are three of the most widely used search engines in Neuropsychology, Neuroscience and Medicine. Accordingly, it was anticipated that all relevant articles would be identified through these databases. As there is not a universally used term for EFT, it was necessary to use a number of subtly different search terms in order to capture all articles of interest. The search included peer reviewed articles published up until September 2016 containing the term "worry" or "anxiety" or "anxiety disorder*" in the topic and one or more of the following terms: "future episodic thinking", "future episodic thought*", "future thinking", "future experiencing", "imagining the future", "future mental time travel", "future-oriented thinking", episodic foresight" and "anticipation of future experience*".

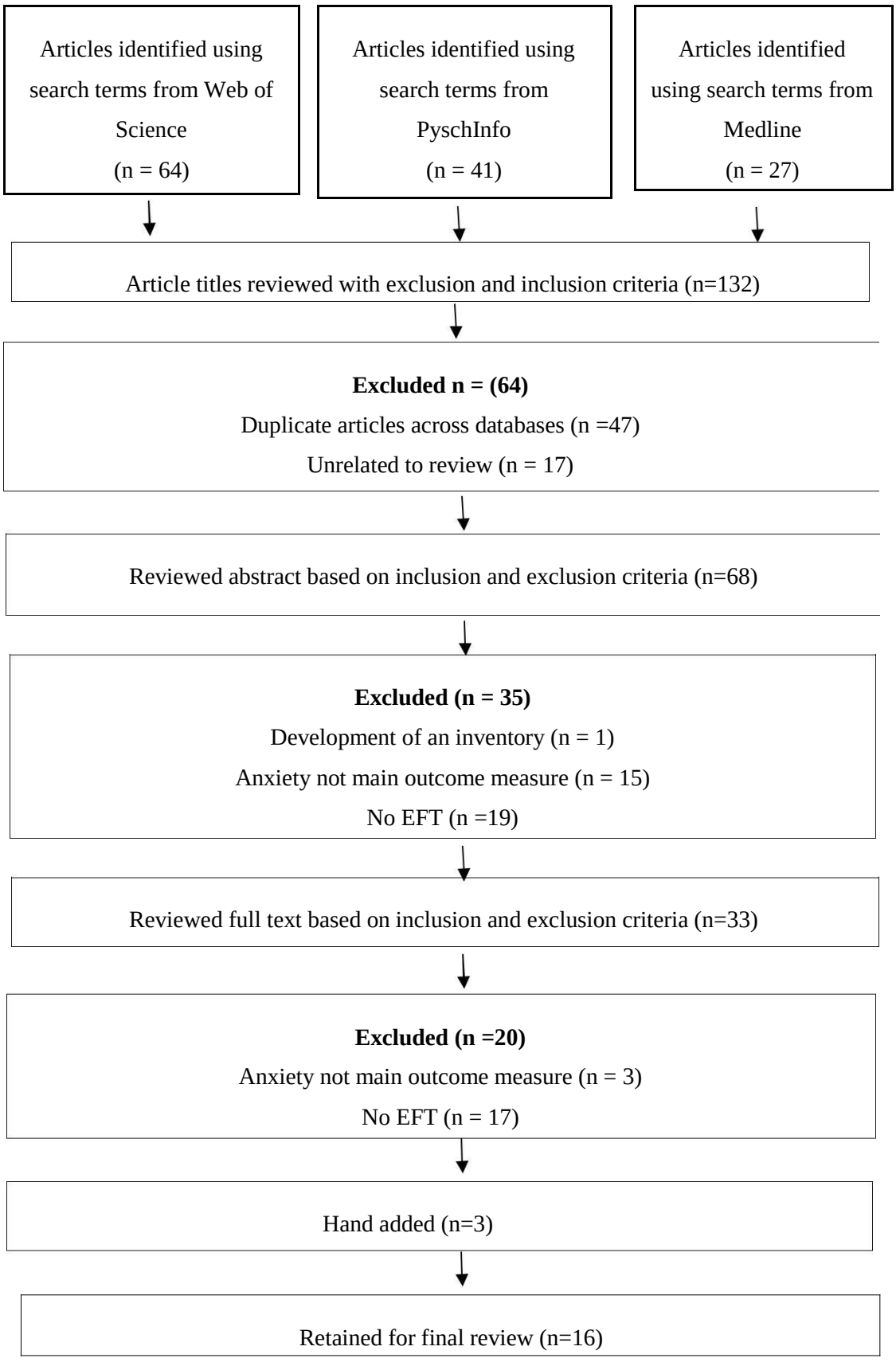

Figure 2: Flow Chart to Illustrate the Study Selection Process

1.2.2 Inclusion and Exclusion Criteria

The focus of this literature review is to identify original experimental studies that investigated the relationship between EFT and anxiety. Therefore, it excludes reviews, book chapters, proceedings papers, theoretical articles and unpublished dissertations to ensure a high calibre of studies reviewed. The articles included in this literature review had all been peer reviewed for publication using quantitative methodology, either alone or alongside qualitative analysis, and written in English.

The studies included all contained an EFT task which required the participants to imagine themselves experiencing at least one event at any point in the future. They also contained a group of participants experiencing some symptoms of anxiety, not necessarily reaching a clinical threshold, but identifiable by a validated anxiety or worry outcome measure or sub-scale. Studies that included participants with anxiety symptoms that were co-morbid with a psychiatric disorder (other than an anxiety disorder) listed in the Diagnostic and Statistical Manual (DSM-5; APA, 2013) were excluded. [1]

The studies included participants between the ages of 11 – 65. The minimum age criterion was chosen reflecting Piaget's theory of the stages of cognitive development (Piaget, 1936), which states that it is around this age that children are able to think in an abstract way. This allows for the consideration of possible future scenarios, which is a pre-requisite for EFT. The rationale for stating a maximum age stems from studies indicating how cognitive abilities, particularly those related to EFT, tend to decline in late adulthood (Addis, Wong & Schacter, 2008) as well as the recognition that symptoms of anxiety can present differently amongst older adults (Bassil, Ghandour & Grossberg, 2011).

[1] Since Post Traumatic Stress Disorder (PTSD) and Obsessive Compulsive Disorder (OCD) are no longer categorised as anxiety disorders (DSM-5; APA, 2013), identified papers that focused on outcome measures relating to these conditions were excluded.

A process of shortlisting and reading abstracts helped to determine whether the papers met the inclusion criteria. This identified 13 papers, with three further papers accessed through hand-searching. A search of the associated reference lists of these 16 papers found no further suitable articles (figure 2.)

1.2.3 Quality Assessment of Identified Papers

In order to assist with the assessment of the internal validity of the studies included in the literature review, the quantitative scoring system from the QualSyst assessment tool was administered (Kmet, Lee & Cook, 2004) (Appendix A). This is a checklist which examines how well a study's design, conduct and analyses reduce the possibility for errors and biases. This assessment tool was chosen as it provides an efficient, systematic method of assessing research papers with a variety of study designs.

Each study in the literature review was given a summary score. This was calculated according to the degree to which they met 14 items on the QualSyst checklist. Each item was scored on a scale of 0 to 2; a score of zero indicated that the criteria had not been met, a score of one reflected criteria that had been partially met and a score of two was awarded when the criteria had been fulfilled. Items that were not applicable to a particular study design were marked 'n/a' and were excluded from the total summary score. These scores were transferred into a decimal fraction for ease of comparison.

As all the studies identified from the search were from peer-reviewed publications, it was anticipated that they would all be of a reasonably high standard. Summary scores calculated from the QualSyst checklist were converted into decimal fractions. Based on guidance from Kmet and colleagues (2004), a minimum threshold was set at 0.60.

1.3 Results

1.3.1 Overview of Identified Papers

Sixteen papers were identified from 15 different journals for this literature review (Table 1). The research studies were conducted across seven countries. The articles were published across a 19 year period, between 1996 and 2015. The majority of the papers utilised a cross-sectional design; only one provided longitudinal data. Sample sizes ranged considerably from 35 to 222 participants. Eleven studies used a student population. Across all the studies, the mean ages reported ranged from 13.55 to 45.5 years.

The ability to pre-live future events has been discussed in a variety of research areas of psychology, cognitive science and neuropsychology. However, the absence of consensus for a universal term to describe EFT is a challenge when conducting a systematic literature review. The 16 papers referred to EFT in nine different ways (Table 2) and there was a variety of methodology reported for the EFT tasks. There was also a diverse range of anxiety and worry outcome measures used in the studies. Four papers used both anxiety and worry outcome measures, two focused only on worry measures and the remaining majority focused on anxiety measures. There were 11 state anxiety measures and three trait anxiety measures. Six papers measured trait worry through the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger & Borkovec, 1990).

The QualSyst checklist and summary rating for each of the papers is presented in Table 3. These ranged from 0.71 to 0.96. None of the papers identified fell below the advised threshold of 0.60.

Table 1.

Reviewed Studies

Study Authors and Journal	Sample Size	Sample Characteristics	Design	Measures of Anxiety / Worry	Measures of FET	Key Findings	Quality Assessment Score
Andersson, Kyrre Svalastog, Kaldo & Sarkohi (2007) *Journal of Psychosomatic Research*	*n* = 40	Conducted in Sweden 20 tinnitus patients $\bar{x}$ age = 45.5, *SD*= 13.2; 50%♀ 20 healthy controls $\bar{x}$ age = 38.8. *SD* = 13.2; 65%♀	Cross-Sectional	HADS	FTT: Three time periods (next week, year & next five to ten years) and two conditions, future positive and future negative experiences. Participants given one minute to describe as many examples	Tinnitus patients had higher but not statistically significant anxiety scores and anticipated more negative future events than the controls. *t*(38) = 2.2, *p*=.03	19/20

				for each condition and time period.		
Behar et al. (2012) *n* = 108 *Behaviour Therapy*	Psychology undergraduates in USA. $\bar{x}$ age = 18.9; *SD* = 1.34 51%♀	Experimental. Three thinking conditions; positive, negative and neutral hypothetical future events	PSWQ MASQ	Participants asked to record the content of their minds after being described to consider themselves experiencing a specific future event.	Positive future thinking was associated with no change in self-reported anxiety, whilst neutral future thinking was associated with a linear increase in anxiety. $F(1,29) = 6.92$, $p<.05$, $n^2 = 0.19$).	22/26

					Negative future thinking was initially associated with a short decrease in anxiety, but after 2.5 minutes it increased $F(1,32) = 8.40$, $p<.01$, $n^2 = 0.21$).	
Berntsen, Rubin & Salgado (2015) Study 3. *Consciousness and Cognition*	*n* = 200 $\bar{x}$ age = 33.72, *SD* = 9.44 45%♀	American residents	Cross-Sectional	PSWQ GAD-7	IMAI: A questionnaire with 10 items that assessed the frequency of specified involuntary imagined future events	Positive correlations between anxiety and worry scores and frequency of involuntary specified EFT (*r*= .30 and *r* = .32 respectively)	19/20

Boelen, Huntjens & van den Hout (2014) *Memory*	*n* = 142 University students in the Netherlands $\bar{x}$ age = 21.5, *SD* = 2.3 90 %♀	Longitudinal (1 year follow up)	BAI	SCEFT-2: Participants completed nine sentences simulating possible future events	The proportion of specific and overgeneral responses for possible future events were not significantly associated with general anxiety scores.	18/20
Byrne & McLeod (1997) *The British Psychological Society*	*n* = 75 University students in the UK 25 anxious participants $\bar{x}$ age = 24.2 84%♀ 25 anxious and depressed participants	Cross-Sectional	ADM PSE	Participants were asked to provide explanations for a range of future positive and negative events.	The two mood disturbed participant groups gave more internal and global reasons for experiencing negative events than positive events in the future than the	23/24

	$\bar{x}$ age = 21.2 88%♀ 25 healthy controls $\bar{x}$ age = 22.6 72%♀)				control group. Contrary to the hypothesis, the anxious participants provided fewer explanations for the occurrence of negative events compared to the anxious and depressed group.	
De Vito, Neroni, Gamboz, Della Sala & Brandimonte (2015) *The Quarterly Journal of*	*n* = 35 Undergraduate students in Italy $\bar{x}$ age = 20.61, *SD* = 4.03 69% ♀	Cross-Sectional	STAI	Participants were asked to generate four desirable and four undesirable novel, plausible future events	Participants with higher trait anxiety scores provided more internal event details for both desirable and undesirable event descriptions.	16/20

Experimental Psychology					triggered from eight cue words		
Dickson, Moberly, Hannon & Bates (2009) *Journal of Research in Personality*	*n* = 82	Undergraduate students in London $\bar{x}$ age = 27.3, *SD* = 6.3 (% ♀ not stated)	Cross-Sectional	MAS	Participants were asked to write down four events they could imagine themselves feeling a stated negative emotion in the future.	Self-reporting scores of event intensity and importance were positively correlated with trait anxiety (*r* = 0.26 and *r* = 0.27 respectively).	17/20
Finnbogadóttir & Berntsen (2013) *Consciousness and Cognition*	*n* = 34 (the same participants from the authors 2011 study listed below)	Undergraduate students in Denmark $\bar{x}$ age = 23.62, *SD* = 23.62 18 high worriers (83% ♀)	Cross-Sectional	PSWQ	A diary	There was no significant difference between high and low worriers in their reported frequency of involuntary mental time travel. $F(1,31) = 1.86$, $p = .18$, $\eta^2_p =$	18/22

		16 low worriers (69% ♀)				.06[5]. There was no evidence of reduced positivity bias amongst the high worriers describing future events.	
Finnbogadóttir & Berntsen (2011) *Memory*	*n* = 36	Undergraduate students in Denmark $\bar{x}$ age = 23.62 20 high worriers (85% ♀) 16 low worriers (69% ♀)	Cross-Sectional	PSWQ	A diary	High worries rated their memories and future projections (both voluntary and spontaneous) as having lower self-relevance than the low worries. $F(1,34) = 4.02$, $p = .05$, $\eta^2_p = .11$)	20/24
MacLeod & Byrne (1996)	*n* = 75	Undergraduate students in UK.	Cross Sectional	PSWQ ADM	Personal- Future Task: Three time periods (next	There was a significant difference in the mean number	0.86

Journal of Abnormal Psychology	25 anxious age = 24 84%♀ 25 depressed and anxious $\bar{x}$ age = 21 88%♀ 25 healthy controls age = 23 28%♀	week, year, and next five to ten years) and two conditions, future positive and future negative experiences. Participants given one minute to describe as many examples for each condition and time period.	of future negative experiences generated by the controls (12.5) compared to the anxiety group (15.6) and the mixed anxiety and depression group. (17.1), but the clinical groups did not differ significantly from each other. The anxious group reported slightly less positive experiences than the healthy control group, but it was not statistically

						significant ($\bar{x}$= 20.3 versus 22.7)	
MacLeod, Tata, Kentish & Jacobsen (1997) *Cognition and Emotion*	*n* = 50	Conducted in UK 17 patients with panic disorder $\bar{x}$ age = 31 59%♀ 16 patients with MDD $\bar{x}$ age = 41 63%♀ 17 controls $\bar{x}$ age = 38 53%♀	Cross-Sectional	BAI PANAS	PFT: Three time periods (next week, year, and next five to ten years) and two conditions, future positive and future negative experiences. Participants given one minute to describe as many examples for each condition and time period.	The anxious patients provided the most anticipated negative experiences $F(2,47) = 6.8$, $p<.01$	18/22

McElwee & Haugh (2010) *Self and Identity*	Study 2: *n* = 222	Psychology students at an American University $\bar{x}$ age = 19.97, SD = 4.40 59.9%♀	Cross-Sectional	MASQ PANAS	FST PSQ	The level of detail recorded for the "feared self" narrative was positively correlated with the frequency with which it is thought about (*r* =.14, *p*<.05 and how soon it is imagined the "feared self" may occur (*r*=.17, *p*<.05)	19/20
Miles, MacLeod & Pote (2004) *Journal of Adolescence*	*n* = 123	Secondary school students in England. $\bar{x}$ age = 13.55, SD = 1.39.	Cross Sectional	RCMAS PANAS	Memory/ Future Thinking Task: Three time periods (next week, year, and next five to ten years), two	Anxious participants wrote more negative responses in both the past and future conditions than their controls. $F(1,48) = 5.14$, $p = 0.03$	19/22

	23 depressed 42 non-depressed controls 28 anxious (64% ♀) 23 non-anxious control group (74% ♀)			conditions (past and future) and two response valences (positive and negative). Participants given one minute to write down as many examples for each condition, time period.	However, there was no significant difference between the number of positive responses generated in either condition between the anxious participants and their controls.	
Quoidbach, Wood & Hansenne (2009)	*n* = 106 University workers, location not stated. $\bar{x}$ ♀ age = 33.1, SD = 10.76	Experimental. Three thinking conditions; positive, negative and	STAI	Participants asked to imagine and record four events they can imagine	Anxiety scores significantly reduced amongst participants in the neutral thinking condition,	17/24

The Journal of Positive Psychology		$\bar{x}$ ♂ age = 35.03, SD = 14.8 15 Positive Condition (60% ♀) 16 Negative Condition (56% ♀) 18 Neutral Condition (72% ♀) 57 Controls (6% ♀)	neutral hypothetical future events.		experiencing tomorrow.	*F*(1,102) = 5.64, *p*<0.02.	
Sansom-Daly, Bryant, Cohn & Wakefield (2014) *Anxiety, Stress and Coping*	*n* = 60	Undergraduate Psychology students in Australia with varying levels of health anxiety (35% clinical level	Experimental 2 conditions; Experiential group instructed "to focus attention" on a	SHAI DASS-21	FIT: Participants asked to imagine specific future events in response to 15 cue words (five positive, five	Higher health anxiety was positively correlated with more illness-related future thoughts (*r* = .275, *p* <.034)	19/20

		for hypochondriasis) $\bar{x}$ age = 19.2, *SD* = 2.69 68.3%♀	set of personal experiences. Analytical group instructed to "think about" a set of personal experiences		negative and five somatic)		
Wu, Szpunar, Godovich, Schacter & Hofmann (2015) *Journal of Anxiety Disorders*	*n* = 40	Conducted in Boston, USA. 21 participants with GAD ($\bar{x}$ age = 25.67, SD = 11.23, 71.4%♀). 19 healthy controls ($\bar{x}$ age = 28.42, SD = 12.35. 68.4%♀)	Experimental	PSWQ BAI	ERP: 90 novel person-location-object triads used as cues for positive, negative and neutral future events	There was no difference between the two groups level of detail, but the GAD group did show less increases in detail with repeated simulation *t*(380) = 2.35, *p* = 0.026	20/22

Note. ADM = Anxiety and Depression Measure (Goldberg, Bridges, Duncan-Jones & Grayson, 1988). BAI = Beck Anxiety Inventory (Beck, Epstein, Brown & Steer, 1988). DASS-21 = Depression, Anxiety, Stress Scales – Short Form (Lovibond & Lovibond, 1995). ERP = Experimental Recombination Procedure (Szpunar & Schacter, 2013). FET = Future Event Task (Williams et al., 1996). FIT = Future Imaginings Task (Williams et al., 1996). FST = Future Self Thoughts (McElwee & Haugh, 2010). FTT = Future Thinking Task (Macleod, Rose & Williams, 1993). GAD = Generalised Anxiety Disorder (APA, 2013). HADS = Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983). IAMI = Involuntary Autobiographical Memory Inventory (Berntsen, Rubin, Salgado, 2015). MAS = Manifest Anxiety Scale (Butcher, Dahlstrom, Graham, Tellegen & Kaemmer, 1989). MASQ = Mood and Anxiety Symptom Questionnaire (Watson & Clark, 1991). PANAS = Positive and Negative Affect Scale (Watson, Clark & Tellegen, 1988). PSWQ = Penn State Worry Questionnaire (Meyer, Miller, Metzger & Borkovec, 1990). PFT = Personal-Future Task (MacLeod & Byrne, 1996). PSE = Present State Examination (Wing, Cooper & Sartorius, 1974). PSQ = Possible Selves Questionnaire (Markus, 1987). RCMAS = Revised Children's Manifest Anxiety Scale (Reynolds & Richmond, 1978). SCEFT-2 = Sentence Completion for Events in the Future Test (Boelen, Huntjens & van den Hout, 2014). SHAI = Short Health Anxiety Inventory (Salkovskis, Rimes, Warwick & Clark, 2002). STAI = State Trait Anxiety Inventory (Speilberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). TAU = Treatment as Usual. UK = United Kingdom. USA = United States of America. WDQ = Worry Domains Questionnaire (Tallis, Davey & Bond, 1994).

Table 2.

Episodic Future Thinking Terminology

Terminology	Papers
"Future Thinking"	Andersson et al. (2007) Behar et al. (2012) Byrne & MacLeod (1997) Sansom-Daly et al. (2014)
"Future MTT"	Finnbogadottir & Berntsen (2013) Finnbogadottir & Berntsen (2011) Quoidbach et al. (2009)
"(Anticipation of) Future Experiences"	MacLeod & Byrne (1996) MacLeod, et al. (1997)
"Episodic Future Thinking"	de Vito, et al. (2015) Wu et al. (2015)
"Future Thoughts"	Berntsen et al. (2015)
"Prospection"	Boelen et al. (2014)
Imagined Future Experiences	Dickson et al. (2009)
"Future Self"	McElwee & Haugh (2010)
"Prospective Cognitions"	Miles et al. (2004)

The quality of each paper was reviewed according to the QualSyst criteria listed in Appendix A.

Table 3.

QualSyst Ratings

	Criteria															
Paper	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Summary Score	Quality Rating
Byrne & MacLeod (1997)	2	2	1	2	N/A	2	N/A	1	2	2	2	2	2	2	23/24	0.96
Andersson et al (2007)	2	2	1	2	N/A	N/A	N/A	2	2	2	2	N/A	2	2	19/20`	0.95
Berntsen et al. (2015	2	2	1	2	N/A	N/A	N/A	2	2	2	2	N/A	2	2	19/20	0.95
McElwee & Haugh (2010)	2	2	1	2	N/A	N/A	N/A	2	2	2	2	N/A	2	2	19/20	0.95
Sansom-Daly et al. (2014)	1	2	2	2	N/A	N/A	N/A	2	2	2	2	N/A	2	2	19/20	0.95
Wu et al. (2015)	2	2	1	2	N/A	N/A	N/A	2	2	2	2	1	2	2	20/22	0.91
Boelen et al. (2014)	2	2	1	2	N/A	N/A	N/A	2	2	2	2	N/A	2	1	18/20	0.90

MacLeod & Byrne (1996)	2	2	2	1	N/A	N/A	N/A	1	2	2	2	1	2	2	19/22	0.86
Miles et al. (2004)	1	2	2	2	N/A	N/A	N/A	1	2	2	2	1	2	2	19/22	0.86
Behar et al. (2012)	1	2	1	2	1	2	N/A	2	2	2	2	1	2	2	22/26	0.85
Dickson et al. (2009)	2	2	2	1	N/A	N/A	N/A	2	2	2	0	N/A	2	2	17/20	0.85
Finnbogadóttir & Berntsen (2011)	1	2	1	1	N/A	2	N/A	2	2	2	2	1	2	2	20/24	0.83
Finnbogadóttir & Berntsen (2013)	2	2	1	2	N/A	N/A	N/A	0	2	2	2	1	2	2	18/22	0.82
MacLeod et al. 1997	2	2	1	1	N/A	N/A	N/A	2	1	2	2	1	2	2	18/22	0.82
de Vito et al (2015)	2	2	1	2	N/A	N/A	N/A	2	1	2	1	N/A	1	2	16/20	0.80
Quoidbach et al. (2009)	2	2	1	1	1	N/A	N/A	2	1	2	1	0	2	2	17/24	0.71

1.4 Discussion

In order to manage the diversity of the studies identified in the systematic literature review, a narrative synthesis approach was undertaken (Popay, Roberts, Sowden & Duffy, 2006).

1.4.1 Measures of Anxiety and Frequency of Episodic Future Thinking

Hypothesis 1: Individuals with higher measures of anxiety will engage in EFT more frequently than individuals with lower measures of anxiety

Whilst there was no consensus of opinion amongst the three papers that discussed EFT frequency and anxiety measures, the emerging evidence leans towards supporting the hypothesis. The studies reporting evidence in favour of this relationship were ones that had the highest QualSyst rating. McElwee and Haugh (2010) identify a positive correlation between frequency of thoughts about the future and self-reporting measures of anxiety amongst 222 psychology students. Berntsen and colleagues (2015) also reported positive correlations between the frequency of involuntary EFT, recorded on a 10 item questionnaire, and self-reported anxiety and worry scores from 200 American residents.

Conversely, one of the reviewed studies did not find a significant difference in the amount of involuntary future projections experienced by high and low worriers. Finnbogadóttir and Berntsen (2013) investigated the frequency of involuntary MTT in the context of high and low levels of trait worry through a sample of 34 undergraduate students who recorded each incident of past and future MTT in a notebook for a day. However, their findings should be considered with a degree of caution. Thirty-nine percent of the participants, initially identified as high worriers by their scores on the PSWQ, reported scores below the high trait worry threshold at the end of the study. The authors suggested this could be due to demand characteristics because the participants may have considered completing the diary a therapeutic intervention (Finnbogadóttir & Berntsen,

2013). There is also a potential flaw with the mode of data collection; participants reported difficulty recording their involuntary MTT during certain activities. This is likely to have impacted on the accuracy in terms of how frequently MTT occurred.

Overall, it appears that anxious individuals have no difficulty with EFT and do not avoid engaging in the process. One of the papers did not directly address frequency, but instead reflected on the ease of EFT, which is a closely related element. Wu and colleagues (2015) found no difference in the ease with which 21 patients with Generalised Anxiety Disorder (GAD) and healthy controls engage in planned EFT.

In summary, with the three identified studies addressing the relationship between anxiety and frequency of EFT presenting differing results, it is inappropriate to draw a firm conclusion in response to the hypothesis. However, from these preliminary findings it would suggest that there is some support in favour of the proposed relationship.

1.4.2 Measures of Anxiety and Valence of Episodic Future Thinking

Hypothesis 2: Individuals with higher measures of anxiety will report experiencing more negative content, but no difference in the amount of positive content in their EFT, when compared with individuals with lower measures of anxiety.

The most common theme running through the identified articles was the way in which the cognitive and emotional content of EFT relates to measures of anxiety. Six of the nine papers reported evidence supporting the review's hypothesis (Andersson et al., 2007; Behar et al., 2012; MacLeod & Byrne, 1996, MacLeod et al., 1997; Miles et al., 2004; Sansom-Daly et al., 2014). Their findings are presented in the order of their QualSyst ratings; the five papers that focus on anxiety outcome measures are discussed first, before the one paper with a worry measure. This is followed by a discussion on the

results of the three papers that go against the hypothesis (Finnbogadóttir & Berntsen, 2013; Quoidbach et al., 2009; Wu et al., 2015)

Andersson and colleagues (2007) reported 20 tinnitus patients having higher, but not statistically significant, self-reported state anxiety scores than 20 healthy controls. These patients expressed more negative events during an EFT task compared with the controls, but there were no group differences in the amount of positive EFT reported. Andersson and colleagues (2007) reflect on their clinical experience with this population, acknowledging that many patients worry about their condition deteriorating. It may be that this worry fuels a bias towards negative EFT, particularly amongst those participants with health related anxiety related to conditions with a potentially poor prognosis.

Further evidence for the hypothesis was reported in the study by Sansom-Daly and colleagues (2014). This paper, which had the same high QualSyst rating as Andersson and colleagues (2007), observed how higher scores of health anxiety that were independent of physical health correlated positively with more negative illness related EFT (Sansom-Daly et al. 2014.). Sixty undergraduate students with varying scores on the short health anxiety inventory (SHAI; Salkovskis, Rimes, Warwick & Clark, 2002) described 30 EFT events in response to equal amounts of positive, negative and somatic words cues.

MacLeod and Byrne (1996) found that a group of 25 undergraduates who scored highly on the anxiety and depression measure (ADM; Goldberg, Bridges, Duncan-Jones & Grayson, 1988) and who were considered to meet clinical threshold following a clinical interview, reported more negative EFT than the control group. They also reported that the anxious group did report slightly less positive experiences than the controls, but it was not statistically significant. MacLeod and colleagues (1997), using a similar methodology, reported that patients with panic disorder gave more negative responses

when describing anticipated future events than the healthy controls. They reported that the anxious participants did not report fewer numbers of positive EFT.

Miles and colleagues (2004) amended MacLeod and colleagues (1997) methodology to determine whether these findings would be replicated in a non-clinical sample of 123 adolescents aged between 11 and 16. According to the QualSyst rating, this paper was on par with MacLeod and Byrne's 1996 paper. Miles and colleagues (2004) reported that the participants who had a T score of at least 60 on the Revised Children's Manifest Anxiety Scale (Reynolds & Richmond, 1978) recorded more negative responses while engaging in EFT as compared with controls. However, there was no difference between the recorded number of positive responses generated between the groups. The methodology of Miles and colleagues (2004) study may also have had an impact on the findings, as participant responses were written instead of being spoken. It may have helped reduce the possibility of a social desirability bias and been beneficial to shy adolescents. However, given the time constraints with this method, it may have disadvantaged those with handwriting difficulties. Consequently, it may have affected the overall number of EFT events recorded.

In an experimental attempt to simulate worry and explore its impact on self-ratings of anxiety, Behar and colleagues (2012) invited participants to engage repeatedly in negatively valenced EFT. Initially participants reported reduced levels of anxious affect; however their scores on the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988) that were obtained after each of the five periods of repetitive thinking, ultimately increased. This finding reflects the rationale anxious people often give for engaging in worry as discussed in Dugas and colleagues (1998) model of GAD. A critique of this study is ecological validity; it is difficult to determine how well the negative repetitive thinking task replicates the true nature of worry. In this context, the researchers asked the participants to imagine giving a speech, anticipating that it would

generate worry with which most participants could empathise. However, given the many domains of worry, this particular task may contribute to cognitions regarding social anxiety rather than the general process of worry. Nevertheless, the study demonstrates a relationship between anxiety and negative EFT. Behar and colleagues (2012) also found that the anxiety levels amongst the participants engaging in positive EFT remained stable during subsequent thinking periods.

One of the most interesting findings in Behar et al.'s (2012) paper was that repetitive neutral EFT was associated with increasing levels of self-rated anxiety. A possible explanation is that the descriptions given were more impersonal and abstract, a cognitive characteristic that has been linked with anxiety (Borkovec et al., 1983). The increased levels of self-reported anxiety may be reflective of the task given to the neutral future thinking group. These participants were asked to consider the unification of Europe and the associated advantages and disadvantages. This is a politically loaded topic, with which participants at that time may not have been familiar and this perceived ignorance may have fuelled anxiety.

Although the majority of the identified papers provide support for the relationship between anxiety, worry and negative EFT, it is not a universal finding. The paper with the highest QualSyst rating that contradicts the relationship is by Wu et al. (2015). They reported that after purposefully engaging in EFT, both GAD patients and healthy controls found it easier to think of positive future events than negative ones. Finnbogadóttir and Berntsen (2013) also found no evidence of high worriers experiencing less positive EFT than participants with low scores on the PSWQ.

Another paper challenging the accumulating evidence base is by Quoidbach and colleagues (2009). Although this paper received the lowest QualSyst rating in the review of 17/24 (0.71), it is still of a sufficient calibre to be well regarded. The article investigated

the impact of difference valences of future MTT on anxiety. One hundred and six healthy participants were randomly assigned to either one of three experimental groups (positive, negative and neutral), or the control group. Over 15 days, participants imagined four events they could potentially experience tomorrow according to the valence of the group to which they were assigned. Self-reported state and trait anxiety scores did significantly reduce in the neutral projection group, but the measures of anxiety did not change in the positive or negative conditions. Many of the neutral events described were related to daily routines. Therefore, it could be that the reduction in anxiety was due to the opportunity to prepare mentally for these planned activities. This hypothesis accords with the evolutionary theory of EFT, which proposes that mentally pre-living events allows for more effective execution and the consideration of possible consequences of actions reducing the possibility of encountering unexpected outcomes and the associated stress (Szpunar, 2010).

Extrapolating from Beck's cognitive model of anxiety (Beck, 1976) it is hypothesised that anxious individuals would attribute a higher probability for experiencing their negative EFT. Surprisingly only one paper in the review addressed the topic of plausibility. This was the study by Wu et al. (2015) who were given the third highest QualSyst rating. Their findings were in direct contrast to this hypothesis. They reported a trend for healthy controls to rate their negative EFT as slightly more likely after repeated simulation. This finding may not have been observed with a large sample size, but it is worth reflecting on what may have contributed to it. Wu and colleagues (2015) considered whether the controls were more able to engage fully with the task and that the trend for them to describe greater vividness with repeated simulations was equated with greater plausibility.

In reviewing the literature on EFT and its valence, it is evident that more studies are required before reliable conclusions can be drawn, but there appears to be a growing body of evidence in favour of this hypothesis.

1.4.3 Measures of Anxiety and Content of Episodic Future Thinking

Hypothesis 3: Individuals with higher measures of anxiety and/or worry will experience more abstract EFT; specifically their EFT will contain less imagery and specific detail, and be more temporally distant than individuals with lower levels of worry

There is an apparent relationship between measures of anxiety and worry and the content of EFT, but as with valence, there does not appear to be a consistent view. Three papers presented findings in support of the hypothesis (Behar et al., 2012; McElwee & Haugh, 2010 & Wu et al., 2015) and two papers describe results that challenge the hypothesis (Boelen et al., 2014; Finnbogadóttir & Berntsen, 2011). These will be reviewed according to the three elements that contribute to abstractness.

1.4.3.1 Specificity

McElwee and Haugh (2010) found that students describing EFT with greater clarity were less worried about their future. A similar finding was reported in a clinical sample; patients with GAD reported significantly less detail in their EFT descriptions than healthy controls (Wu et al., 2015). Patients with GAD are seemingly less able to continue providing concrete details about a future event once it has been generated. This potential deficit warrants further investigation.

Behar and colleagues (2012) aimed to investigate whether the process of worry leads to reduced concreteness in EFT or whether it is thinking in an abstract way that contributes to worry. They reported results that partially supported Stöber's (1998) reduced concreteness theory of worry. They found that when 108 undergraduates engaged in five consecutive periods of repetitive EFT, their descriptions were rated as increasingly less concrete with each period of thinking. This suggests that worry is associated with increasingly abstract cognitions. However, one potential critique of the paper is that it does not reflect on the possibility that boredom or fatigue contributed to the reduced concrete

detail in the descriptions. It is also unclear as to how well the repetitive thinking reflected the process of worry.

Not all of the identified studies support the concept of reduced specificity correlating with anxiety and worry. The paper by Boelen and colleagues (2014) (which was ranked 4th in the QualSyst ratings) reported that the level of specificity given by the 142 students who generated EFT through completing nine sentences was not significantly associated with state anxiety scores obtained at the time of the study or during the one year follow up.

Finnbogadóttir and Berntsen (2011) did not find a significant difference in the level of specificity in EFT between individuals scoring high and low on a self-reported worry measure. De Vito and colleagues (2015) described a tendency for 35 undergraduate students with higher state anxiety scores to provide more temporal and spatial details relating to the future. This was regardless of whether they were describing a desirable or undesirable event, as compared with the students with lower state-trait anxiety inventory scores.

1.4.3.2 Imagery

Reduced imagery has been associated with abstract thought as depicted in the cognitive avoidance model. Of the papers which address this topic, the highest QualSyst rating was given to McElwee and Haugh (2010). They reported that greater clarity in the imagery of EFT was associated with a greater number of positive cognitions, less negative EFT, and lower measures of anxiety. Further support for the hypothesis came from Behar et al. (2012). They found that during negative EFT, abstract thinking was associated with less imagery, a relationship that was not significant during positive or neutral EFT. However, not all the papers that considered imagery and EFT supported the hypothesis. The most recent of the identified papers did not find a difference in the vividness of EFT

between patients with GAD and healthy controls (Wu et al., 2015). Finnbogadóttir and Berntsen (2011) also found no difference in the level of imagery between the participants with high and low worry scores.

1.4.3.3 Temporal Distance

There is substantial evidence to suggest that the more temporally distant MTT is from the present, the more abstract thoughts become (Trope & Liberman, 2003). This appears to be linked to the level of uncertainty associated with the long-term future and ties into theories of worry where difficulties of tolerating uncertainty is a key proponent of anxiety disorders (Dugas, 1998). Although the study conducted by Behar and colleagues (2012) was not primarily concerned with investigating the relationship between anxiety and temporal distance (i.e. how far into the future individuals imagined themselves experiencing events) the authors discuss one of its unexpected findings within this context. They found that participants in the neutral EFT condition exhibited greater levels of self-reported anxiety with each subsequent period of thinking. The authors postulated that their positive and negative conditions involved thinking about potential events in the immediate future. However, it could be argued that the neutral condition allowed for more distant future MTT.

In summary, the papers that considered the relationship between measures of anxiety and abstract EFT present a mixed picture. There is slightly more evidence in favour of the hypothesis but further studies are required.

1.4.4 Measures of Anxiety and Self-Relevance of Episodic Future Thinking

Hypothesis 4: Individuals with higher measures of anxiety will engage in less self-relevant EFT than individuals with lower measures of anxiety.

Two of the reviewed papers discussed the personal saliency of EFT in relation to worry, but with conflicting findings (Dickson et al., 2009; Finnbogadóttir & Berntsen, 2011). The paper with the slightly higher QualSyst rating is Dickson and colleagues (2009). They reported a positive correlation between the rated importance of four future events and trait anxiety scores obtained from 82 undergraduates, contradicting the Cognitive Avoidance theory (Borkovec et al., 1983). However, these results should be reviewed cautiously. Whilst the participants were asked to record their responses in writing anonymously, it is possible that the presence of the experimenter observing them throughout the task may have introduced a social desirability bias. Although the participants were not instructed to generate events of personal importance, this setting may have resulted in increased ratings amongst individuals who wished to be perceived as completing the task well.

The second paper, by Finnbogadóttir and Berntsen (2011), presented preliminary findings in favour of the review's hypothesis. They described how 20 participants with higher scores on the PSWQ, corresponding to higher levels of trait worry, rated their voluntary and involuntary EFT as less self-relevant as compared with 16 participants with lower PSWQ scores. Specifically, those who identified themselves as having high trait worry rated their future projections as less important and less related to their identity. Although the differences between the two groups were small, the mean effect size was moderate[2]. This study's methodology did not assess whether the worriers recorded less salient events then the participants with low levels of worry. It may be that the anxious disposition of high worriers impacts on what they consider personally significant. Therefore, they interpret these future projections as less self-relevant. Finnbogadóttir and Berntsen (2011) considered whether it is possible that the low worriers scored unusually

[2] The effects size (Cohen's *d*) for the three questions measuring self-relevance ranged from .51 to .52.

highly on the self-relevance measures as opposed to the high worriers having notably lower scores. An improvement to the method would have been to have included participants with median levels of worry (Finnbogadóttir & Berntsen, 2011).

Berntsen and Rubin (2006) postulated that individuals with high trait worry may envision less personally significant events as a means of avoiding intense emotions. However, in this study there was no significant difference between the high and low worriers in their reported levels of emotional intensity. Therefore, the possibility that worriers experience less personally relevant EFT, as part of a cognitive avoidance pattern, remains unclear and consequently an area for future research.

1.4.5 Is Negative Episodic Future Thinking a Result of Anxiety?

The majority of the reviewed studies consider the association between measures of anxiety and EFT, reporting correlational findings. However, the direction of this relationship remains unclear. The issue is whether negative EFT is a consequence of anxiety or is the emotion a side effect of negative future projections? Quoidbach and colleagues (2009) proposed that their lack of an association between negative EFT and increasing anxiety scores may indicate that voluntary negative EFT does not directly cause anxiety, but that it may occur as a side effect of trait anxiety. It is possible that personality traits impact the valence of EFT, which then influences mood in an indirect way. For example, neuroticism is a personality trait that can lead to catastrophising and worry (Thompson, 2008). This trait is a measure included in one of the identified papers (Finnbogadóttir & Berntsen, 2013) and was positively correlated with high levels of worry.

Quoidbach and colleagues (2009) consider whether the observed relationship between negative EFT and anxiety found in other studies is due to anxious people thinking of more troublesome future events than healthy individuals. Alternatively, anxious individuals may have a heightened sensitivity to emotions when thinking about negative

future events. Both of these hypotheses could be supported by trait neuroticism as this is associated with pessimistic attributions and a more fragile emotional disposition (Matthews & Dreary, 1998). It may be that neuroticism is just one factor involved in the relationship between negative EFT and anxiety; other personality traits like optimism or resilience may also be involved.

1.4.6 Clinical Implications

Vos and colleagues (2015) reported that anxiety disorders are now amongst the most prevalent mental health conditions worldwide, resulting in significant personal distress and an increased burden to health services. Therefore, there is an ongoing need to develop clinical interventions that can complement psychotropic medication.

Anticipating experiencing the future positively is crucial to psychological wellbeing (Walker & Skowronski, 2009). It is thought that this is a skill that can be enhanced through generating optimism and hopefulness, that could act as an antidote to depression and anxiety. Mental simulations of plausible future events tend to encompass the individual's current emotional state (Gilbert & Wilson, 2007). It appears there may be a difference in how involuntary EFT is triggered in people self-reporting higher levels of anxiety. Finnbogadóttir and Berntsen (2011) discuss how participants with higher measures of trait worry reported being in a significantly less positive mood than those with lower measures of worry prior to experiencing MTT. They also noted a trend for the participants with higher measures of worry to report no specific triggers to their EFT. This suggests that it is not perhaps the presence of a negative cognition that acts as a catalyst, but the negative affect. One possible technique that could the influence the content of EFT and consequent mood is through daily practice of generating specific EFT, as discussed by Quoidbach and colleagues (2009).

As this review has identified, it is not only the content of EFT that can have an impact on mood, but it is the quality in which future events are imagined. With this in mind, Behar and colleagues (2012) propose that providing individuals with training on imagery can increase concreteness of thought and consequently may be a therapeutic intervention for individuals with high trait worry. If further studies are conducted using a clinical population to test the efficacy of imagery training on generating EFT, then these ideas could be developed into self-help tools accessible via an app for wider dissemination.

The apparent difficulty that anxious individuals, particularly those with GAD, have in providing details of EFT after repeated simulations, may also have implications for the use of imaginal reliving interventions (Wu et al., 2015). Cognitive Behavioural Therapy (CBT) for anxiety disorders sometimes utilise imaginal exposure where patients simulate in their minds the worst case scenarios they could encounter in order to challenge their catastrophic beliefs (Clark, 1999). Therefore, it is prudent for clinicians offering this intervention to be aware that patients, particularly with GAD, may struggle to construct a comprehensive future image across repeated exposure trials. Nevertheless, it may still be a worthwhile intervention, particularly if it is presented in a way that ensures the generation of concrete future positive imagery. Such an exercise may help prevent anxious individuals from engaging in abstract and verbal worry.

An interesting finding reported by Finnbogadóttir and Berntsen (2013) was that participants with higher measures of trait worry had a tendency to score more highly on the attentional control sub-scale on the Short Imaginal Processes Inventory (SIPI; Huba, Singer, Anehensel & Antrobus, 1982). This indicates a positive correlation between worry and the ease with which the mind wanders. They also noted a significant positive correlation between poor attentional control and the percentage of EFT that was appraised negatively. These findings suggests that increasing attentional control and/or modifying biases towards negative material would have therapeutic benefit.

The literature on mindfulness reflects how a wandering mind to different temporal locations can lead to either rumination or worrying (Harris, 2008). Therefore, the efficacy of mindfulness may be due to the fact that individuals who are focused on their present circumstances without judgement are not able to engage in the cognitive processes that evoke depression and anxiety (Sears, & Kraus, 2009). Whilst it is neither practical nor desirable to remain present-orientated at all times, it would seem that one strategy to disengage from worry and reduce the experience of anxiety would be for individuals to desist from MTT (Killingsworth & Gilbert, 2010). However, the findings from this review suggest that it is not just the frequency of EFT that can contribute to measures of anxiety, but it is how it is experienced. Mindfulness practice often encourages the use of all five senses, enhancing an individual's attention to their current circumstances. In this way, thoughts are less likely to be verbal and abstract, which appears to impede the process of worry. Therefore, it seems that there are multiple facets of mindfulness that can have therapeutic benefits when considering the relationship between EFT and anxiety.

1.4.7 Strengths and Limitations of the Review

This is the first systematic literature review offering a detailed investigation into the methodology and results covering all relevant studies focusing on EFT and anxiety. The relatively low numbers of included papers reflects how recently these two entities have been considered together. By establishing a definition of what constitutes EFT, regardless of the different terms used for it, this systematic method should allow the same 16 papers to be identified. These papers included quantitative analysis that allowed for discussion on the three main aims of the literature review. Specifically, whether there was a relationship between frequency of EFT and anxiety, whether anxious individuals engage in EFT in a different way to less anxious people and how EFT may impact on clinical interventions.

1.4.7.1 Limitations of the Review Method

The decision to exclude grey literature[3] from the search may have resulted in overlooking information that could be relevant to expanding the evidence base in this field. Accessing grey literature can be challenging, as such resources are not always in the public domain or discoverable through search engines. The advantage of including them in literature searches is that they can bring to light papers that contain null or contradictory results. Not including them leads to publication bias.

To critically evaluate the identified papers, the QualSyst checklist was used[4]. Whilst this tool is considered to be an improved method of assessing the quality of diverse research designs, it must still be considered critically. The items included in QualSyst reflect the authors' perception of what constitutes good quality in research and therefore may differ from other researchers. Kmet and colleagues (2004) acknowledge that the inter-rater reliability for QualSyst was reviewed using a small sample of test studies (n = 11) and ranged from 73% to 100%. This highlights how even with a detailed manual, subjective interpretation can still occur. Despite these limitations, QualSyst provides a quantifiable framework which can enhance the assessment of research quality.

Although QualSyst offered an objective and replicable method of assessing the quality of the studies, a second rater would have enhanced the scoring integrity. When rating each paper, it is important to recognise that the scoring can only be based on the information reported. Therefore, without consulting with the authors, the summary scores may not be an accurate reflection of the research conducted. One of the main limitations of the QualSyst checklist is that it does not have an item that explicitly assesses the clarity,

[3] Grey literature is material that is produced by organisations outside traditional publication and distribution routes.

[4] The development of this checklist stemmed from established quality assessment tools for quantitative studies, particularly those developed by Cho and Bero (1994) and Timmer, Sutherland and Hilsden (2003).

replicability and suitability of the procedure. It also does not consider the journals' impact factors, which provide a measure of the journal's importance within its field, or the number of citations each paper has accumulated.

Finally, this review does not include a statistical evaluation of the literature or meta-analytic techniques to investigate trends in the data. However, given the range of measures used to assess EFT and anxiety, such an approach would not have been feasible.

1.4.7.2 Limitations from the Papers Identified

1.4.7.2.1 The Challenges of Assessing Episodic Future Thinking

One of the main issues that emerged from conducting this review was whether the EFT tasks described in the papers were truly representative of future mental time travel, particularly as EFT is a subjective and arguably an unquantifiable experience (De Brigard et al,. 2016). There were a number of EFT tasks in which participants were asked to describe as many possible events they could envisage happening to them at a stated time point in the future for one minute (Andersson et al., 2007; Macleod et al., 2004; Miles et al. 2004). Generating so many responses in a limited time period may have reduced the participants' sense of pre-living. As previously discussed it is proposed that autonoetic consciousness differentiates thinking about experiencing events in the future and pre-living these events (Tulving, 1993). Therefore, it could be argued that such tasks are neglecting to include this crucial aspect of EFT. A similar criticism exists for the study by Byrne and MacLeod (1997) who requested participants to think of as many reasons why or why not a specified future events would happen to them in one minute. Whilst this methodology encourages an event to be constructed in the mind's eye, it seems to focus more on its appraisal as opposed to the simulation of pre-living an event.

Another study where it is unclear as to whether the EFT task is a precise measure of future MTT is the one by Finnbogadóttir and Berntsen (2013). In this paper, participants

were instructed to record each incidence of "future projections" they experienced, but it is not reported as to whether a definition of this is provided. The recording sheets have tick boxes for frequency and valence so no further detail on the content of the EFT is provided. This suggests that a future projection may have been EFT, but it also may have been an example of daydreaming or mind-wandering. Such mental activities are conceptually similar, but can differ from EFT if they did not contain any personally experienced episodic content.

The sentence completion task designed by Boelen and colleagues (2014) to assess habitual "envisioned future events" lacks a consistent temporal reference. Two of the nine sentences state a specific time in the future, four sentences give a vague reference to the future (e.g. "later") and the remaining three sentences do not stipulate a time frame. It could be argued that without a temporal framework, participants may not be fully engaging in EFT.

Although the paper by Quoidbach and colleagues (2009) was given the lowest overall quality rating, one of its strengths was the design of the EFT task. Participants were instructed to take their time to imagine specific future events they could anticipate experiencing tomorrow and were asked to provide a summary of their EFT which contained functional, temporal and sensory details. This was also the only paper to investigate the experience of neutrally valenced routine EFT.

Fifty percent of the papers included in this review looked at past and future thinking in the same session, which may have influenced the ease and content for both types of MTT. Aside from the methodology described by Wu and colleagues (2015), none of the papers consider how often the participants may have thought about particular past and future events prior to engaging in the EFT task. Therefore, it is difficult to determine whether the participants who report more negative EFT are influenced by a general

tendency to view the future more pessimistically or whether their EFT is fuelled by accumulated worry about specific events.

1.4.7.2.2 Participants

There is considerable homogeneity of the participants included in the studies. Ten of the studies' participants were recruited through opportunistic undergraduate student populations rather than clinical populations which has implications for generalising the findings (Crano, Brewer & Lac, 2015). Firstly, this population has a limited age range, usually in their late teens to early twenties. Younger people may engage in EFT differently due to the probability that they have many more years ahead of them (Tonn et al., 2006). Secondly, the academic, social and financial pressures undergraduate students typically encounter, coupled with their future aspirations, may mean that their experience of EFT and anxiety is not representative of the general population or a clinical sample. Thirdly, brains continue to develop past adolescence into the early adulthood (Lebel & Beaulieu, 2011). This may have an impact on the processes involved in EFT, both qualitatively and quantitatively, from those used by older clinical samples. Fourthly, undergraduate students may present with an intellectual bias which could influence their EFT.

Two of the papers explicitly reflected on the difficulty of obtaining a sample of participants experiencing symptoms of anxiety but not depression, which is not surprising given the high levels of co-morbidity with depression and anxiety (Hirschfeld, 2001). MacLeod and Byrne (1996) and Miles and colleagues (2004) reported that the participants in their anxious groups were scoring more highly on self-reporting measures of depression than their control groups.

1.4.7.2.3 Methodology

Whilst worry is an integral part of anxiety and this review's primary focus is on understanding the relationship between EFT and anxiety, it is more difficult to draw

conclusions when there is such a mix of trait and state outcome measures for worry and anxiety in the reviewed papers. It has been proposed that worry is also a cognitive factor in depression (Molina et al., 1998). Therefore, the studies that only included measures of worry may not have solely been addressing anxiety.

Nine of the reviewed studies invited participants to simulate positive and/or negative themed EFT (Andersson et al., 2007; Behar et al., 2012; Finnbogadóttir & Berntsen, 2013; MacLeod & Byrne, 1996, MacLeod et al., 1997; Miles et al., 2004; Quoidbach et al., 2009; Sansom-Daly et al., 2014; Wu et al., 2015). However, some of the papers did not provide clear definitions or examples as to what constituted positive or negative events (e.g. Andersson et al., 2007). It is also unclear as to whether this information was provided to the participants. Furthermore, none of the papers discussed how such terms can incorporate a variety of emotions. For example, MacLeod and colleagues (1997) requested participants engaging in the negative condition to think of something that they were "worried about or not looking forward to", but they did not reflect on how this request could generate two types of negative events that tap into different emotions; anxiety and sadness. The paper by de Vito and colleagues (2015) has a similar issue with its instruction for participants to conjure up "desirable and undesirable" future events. Unfortunately, none of the papers provided detail into the types of negative events generated during the studies. However, Dickson and colleagues (2009) did specify the eight word cues used to generate negative EFT. These were an equal combination of anxious and depressed emotions, but they were not separated accordingly for analysis. An improvement to the methodology could have been to have asked participants to record anxiety provoking EFT, instead of the less specific instruction to record negative EFT. This may have resulted in individuals with measures of high trait worry and anxiety being more influenced by the emotionally weighted wording.

It is difficult to know how well the participants in each study engaged with the EFT task. It is possible that the symptoms of anxiety (and even the symptoms of low mood that were often co-morbid) meant that these individuals lacked motivation or were too distressed to simulate EFT. Behar and colleagues (2012) suggested that measuring trait-mindfulness could provide an estimate as to how well participants are able to sustain their attention to the task at hand. Only Finnbogadóttir and Berntsen (2013) included a measure of attention in their study.

A major limitation of the papers selected for review was the use of self-report measures to assess anxiety and worry, which all of the papers relied on to a varying degree. Questionnaires can be liable to social desirability bias, even when anonymity is confirmed. There was a variety of measures utilised, making direct comparisons between the papers more challenging. Additionally, three of the papers solely used a worry outcome measure (the PSWQ) which does not identify the other components of anxiety that may have been relevant. Whilst all the measures were validated scales, it was felt that it was outside the scope of this review to address the level of validity and acceptability of the measures used, which can influence the quality and integrity of the data.

1.4.8 Areas of Future Research

Interest in the relationship between EFT and anxiety is growing, with emerging data requiring further investigation. Future studies would benefit from larger, more diverse samples. For example, although the participants from the studies included in this literature review were from a breadth of European countries, Australia and the USA, they were all from western cultures with predominantly Caucasian ethnicity. Therefore, recruiting a more diverse population would allow for findings to be applicable cross-culturally. Whilst there is a bias for women to experience anxiety disorders (Bruce et al., 2005), which is reflected in the gender ratio of the samples in these studies, it would be beneficial to

conduct a study that specifically investigates whether there are differences in how anxious men and women experience EFT. It would also be beneficial to conduct longitudinal studies that use a broader age range to determine whether the relationship between anxiety and EFT changes across the lifespan.

In order to reduce the reliance on self-reporting screening measures, clinical interviews such as the Anxiety and Related Disorders Interview Schedule (ADIS-5; Brown & Barlow, 2014) could be utilised. Additionally, measuring physiological levels of arousal, for example through galvanic skin response, could be used to corroborate self-reporting measures of state anxiety. This would help identify whether individuals with higher measures of trait anxiety are more likely to report physiological experiences of anxiety because of hypervigilance to these symptoms or whether they are less likely to notice increased somatic arousal because they have become acclimatised to it. A further area for future exploration is to focus on the development of a specific measure for EFT that incorporates frequency, valence, self-relevance, specificity, imagery, plausibility and emotional arousal. This would be a valuable tool in future research allowing for greater comparability.

Many of the studies included were the first to investigate their topic of interest and so require replication and expansion, particularly with a clinical population. For example, Wu and colleagues (2015) provisional finding that GAD patients may find it a little harder to describe positive EFT after repeated simulations would benefit from further associated research. This could focus on providing support for potential deficits in positive cognitions and determining whether this is an issue experienced across other anxiety disorders. There is considerable heterogeneity amongst the different anxiety disorders and further research is required to determine whether there are differences in how EFT is experienced amongst these different presentations. For example, the results of this systematic search identified how there has yet to be any studies examining the influence of EFT on social anxiety.

Plausibility and temporal context in relation to EFT and anxiety appear to be areas that have few published studies and could benefit from further investigation. Ideally future studies on EFT and anxiety will obtain longitudinal data; only one of the experimental studies included follow-up measures. An emerging area of interest is how neuroticism influences both voluntary and involuntary EFT. The accumulating data suggests that this heightens an anxious disposition, which in turn may lead to more negative abstract EFT.

1.5 Conclusions

There appears to be a complex and not necessarily linear relationship between EFT, worry and anxiety. It seems it is how an individual experiences EFT, which is possibly influenced by neuroticism and other personality traits, which impacts the most on measures of mental wellbeing relating to anxiety. With each hypothesis, the majority of the studies presented findings in favour of them, but with so few papers addressing the topic and some conflicting results more is required before definitive conclusions can be drawn

Although this review's hypothesis stated a positive correlation between measures of anxiety and frequency of EFT, it was not a consistent finding amongst the reviewed papers. The expectation that individuals with higher self-reported measure of worry would have more negative EFT (due to the cognitive aspects of anxiety focusing on experiencing negative outcomes) was observed in some, but not all of the papers. A more frequent finding is that measures of anxiety were not associated with reduced frequency of positive EFT. The content of EFT appears to be a significant factor in psychological wellbeing. There is a trend towards higher measures of anxiety being associated with less concrete EFT. Only one of the papers discussed the issue of plausibility of EFT and its possible interaction with symptoms of anxiety, challenging the notion that individuals with higher ratings of anxiety believe that they are more likely to experience their negative EFT than people with lower measures of anxiety. There was also only one paper suggesting that

thinking about oneself in the more distant future is associated with higher self-ratings of anxiety. Therefore, it is still too early to conclude how these two aspects of EFT interact with measures of anxiety.

The review highlights the discrepancy within the academic and clinical community about the terms used to describe EFT. It is hoped that its dissemination prompts discussion on the need for a consistently used term and definition of EFT, as well as encouraging the development of outcome measures that allow for accurate comparisons across samples.

This review also promotes the need for future research not only to address the causality debate that remains, but also to clarify the emerging themes highlighted from this review. Increased collaboration and replication of studies would greatly benefit this area of research, allowing for more robust findings and clearer conclusions to be made. Specifically the inclusion of more clinical populations may assist the development of new treatment interventions. This could give hope to the many individuals struggling with debilitating symptoms of clinical anxiety, as well as providing a skills framework for maintaining emotional wellbeing in the general population.

Chapter 2: Investigating the Relationship between Remembering the Past and Thinking about the Future

2.1 Introduction

"*It's a poor sort of memory that only works backwards***"** (Lewis Carroll, 1871)

2.1.1 The Role of Episodic Memory in Mental Time Travel

Mental time travel (MTT) is the ability to mentally relive experiences from our past and project ourselves into possible future scenarios (D'Argembeau & Van der Linden, 2006). It involves being able to conjure up a scene in our mind's eye, providing information of where, when and why the event is taking place (Suddendorf & Corballis, 1997). It usually entails visualising objects and people, as well as a recognition of personal thoughts, feelings and information derived from all five senses. The level of detail evoked enhances the authenticity of MTT, whether it is in the past or the future (McElwee & Haugh, 2010).

Tulving (1985) proposes that the key to MTT is autonoetic consciousness. This is the subjective conscious awareness of one's own existence and identity in time that is mediated by sensory input (Ingvar, 1985). Mental time travel requires the ability to disconnect from the present, in order to construct past and future events (Verfaellie, Race & Keane, 2012). It relies on recalling and assembling information contained in autobiographical memory and to provide these mental reconstructions with a temporal context (Suddendorf, 1999). Conway and Pleydell-Pearce (2000) propose that autobiographical memory can be understood as a self-memory system. It involves the recollection of personally experienced events (episodic memories) coupled with

knowledge accumulated during an individual's lifetime (semantic memories) (Williams, Conway & Cohen, 2008).

Mental time travel is a cognitive process that humans engage in both voluntarily and involuntarily on a daily basis (Quoidbach, Wood & Hansenne, 2009; Suddendorf & Busby, 2003). From re-living a first date to imagining a job interview, MTT can be entertaining and functional. There are individual differences in the quality and quantity of MTT (D'Argembeau & Van der Linden, 2006). Neuropsychological case studies have suggested that damage to the medial temporal brain regions involved in episodic memory can have a devastating impact on MTT (Okuda et al., 2003). Recent functional Magnetic Resonance Imaging (fMRI) studies appear to have identified the medial part of the anterior hippocampus as a crucial structure for tasks requiring imagination and recall of scenes and events (Zeidman & Maguire, 2016).

Brain injury, either acquired or through a degenerative condition, that affects either the medial temporal and medial prefrontal lobes or midbrain/diencephalic regions have been shown to be involved in the loss of episodic memories (Schacter, Addis & Buckner, 2007; Smith, 2007). This results in autobiographical amnesia, which can be either anterograde or retrograde[5]. Both types of amnesia often co-exist, but there are a few reported cases of dissociations (e.g. O'Connor, Butters, Millotis, Eslinger & Cermak, 1992). In either case, these deficits cause considerable distress to individuals and their families.

Within the last decade, researchers have considered whether brain injuries that impede episodic memory and consequently MTT to the past, may also impact on the

[5] Anterograde amnesia is a persistent difficulty in storing or retrieving memories subsequent to the brain injury. Retrograde amnesia is an inability to retrieve information acquired before the onset of injury or illness to the brain (Mayes, Daum, Markowisch & Sauter, 1997).

ability to engage in future MTT. Episodic future thinking (EFT) is the process of mentally pre-living events in the future (Addis, Wong & Schacter, 2007). Suddendorf and Corballis (2007) proposed that episodic memory and EFT can be conceptualized as existing at opposing ends of an individual's temporal narrative. Schacter and Addis (2007) developed this theory by proposing that EFT is based on accessing elements of memories accumulated from personal lived experiences and re-combining them to "simulate, imagine or 'pre-experience" events that have never occurred (p.778). According to their constructive episodic simulation hypothesis, a functioning episodic memory system is a pre-requisite for EFT (Schacter & Addis, 2007). Suddendorf and Corballis (2007) support this hypothesis suggesting that MTT in either direction is underpinned by similar cognitive mechanisms and can be understood as being two sides of the same coin.

Autobiographical memories provide the foundation for identity; without them, individuals can feel isolated, frightened and frustrated (Jetten, Haslam, Pugliese, Tonk & Haslam, 2010). Acceptance and Commitment based therapeutic interventions for some amnesic patients can assist them to come to terms with their lost past (Kangas & McDonald, 2011). However, it is also important to reflect on whether their condition entails an absent future. The inability to engage in EFT is likely to have implications for daily activity and mental wellbeing. Without insight to the future, it is difficult to plan for forthcoming events and generate personal goals (Atance & O'Neill, 2001). This can lead to hopelessness and feelings of low self-worth, as well as contributing to low mood and anxiety. Therefore, research into the relationship between episodic memory and EFT has clinical relevance.

This study explores the relationship between episodic memory and EFT. It then considers how the two forms of MTT may differ. These two points of discussion set the scene for the empirical study that follows, which contributes further knowledge in the field of EFT. The study focuses on patients who have a disproportionate impairment of

retrograde memory arising from medial temporal lobe injury, specifically in the hippocampus. It investigates whether the difficulties they have with recalling episodic memories also impacts on their EFT. This is achieved through analysing the patients' performance on a novel MTT task and comparing it to a group of neurotypical controls. The study considers whether any difficulties with past and future MTT is a result of an impaired search and retrieval strategy, as opposed to fragmented scene construction.

2.1.2 The Similarities between Episodic Memory and Episodic Future Thinking

Tulving (1985) was one of the first researchers to suggest a close relationship between episodic memory and EFT. He noted how patient KC, who was experiencing profound amnesia subsequent to a head injury, was unable to formulate any future plans. Klein, Loftus and Kihlstrom (2002) provided similar evidence in the case study of DB, who developed amnesia after cardiac arrest. Patient DB struggled to respond to both past and future questionnaires probing him for episodic memories and EFT. However, it was reported that he had preserved semantic memory and was able to anticipate future issues. Klein and colleagues (2002) proposed that DB's brain injury had not impacted on his noetic consciousness. The effect of DB's brain damage was such that he was able to consider future scenarios, but without personally pre-living them. This distinguishes thinking about the future and EFT (Tulving, 2005).

There is accumulating evidence that episodic memory and EFT share many cognitive, neural and psychological features. Firstly, the ability to remember personally experienced events and imagine experiencing future scenarios appears to develop around the same age in pre-school children (Atance & O'Neill, 2005). This appears to coincide with the development of a sense of self. Children aged three to four years old, are able to recognise themselves as separate, consistent entities that can influence their external world

(Lewis, 1990). It is proposed that self-awareness is a pre-requisite for autonoetic consciousness and, therefore, is a necessary component for MTT (Lind & Bowler, 2008).

Secondly, there appears to be a considerable overlap in the brain regions that are active when individuals engage in past and future MTT. Addis and colleagues asked 16 neurotypical participants to think of past and future events prompted by a cue word before asking them to describe their narratives (Addis & Schacter, 2008). During the mental construction phase, similar level of activity was observed through fMRI in the left hippocampus and posterior visual regions in both past and future conditions. When these participants were elaborating on their descriptions, there was an even greater overlap in the neural activity in the post and future conditions. Addis and Schacter's (2008) study, along with others, have led to the proposal of a core neural network for MTT. This network includes the prefrontal and medial temporal lobes, as well as the posterior cortical regions (Addis & Schacter, 2008; Botzung, Denkova & Manning, 2008; Szpunar, Watson & McDermot, 2007). Addis and Schacter (2008) reported that the level of activity in the left posterior hippocampus was positively correlated with the level of detail given in the past and future conditions. This correlation suggests that the left posterior hippocampus is particularly important for the retrieval of personally experienced events from which EFT is built. It is also provides empirical evidence for Schacter and Addis' (2007) constructive episodic simulation hypothesis.

Thirdly, episodic memory and EFT both involve mental representations that share many features. These include the use of visual imagery, a sense of presence and spatial context and retrieval of autobiographical knowledge (D'Argembeau & Van der Linden, 2006). Mental time travel involves the integration all of these concepts into a structured narrative (Suddendorf & Corballis, 2007). Events that are associated with emotion are usually recalled with greater accuracy and clarity than those which lack emotional detail (Reisberg & Hertel, 2005). It is has been proposed that emotion enhances memory

encoding and retrieval through interactions with the amygdala, hippocampus and prefrontal cortex (LaBar & Cabeza, 2006). The consequence of damage to the neural networks linking these areas is likely to include not only difficulties with retrieving episodic memories, but that the memories that are recalled are emotionally deficient (Buchanan, 2007). It is hypothesised that a diminished emotional connection may impact on the integrity of autonoetic consciousness. This in turn will have a negative effect on the ability to engage fully in MTT, in either direction.

2.1.3 Is Episodic Future Thinking Directly Proportional to Episodic Memory?

The constructive episodic simulation hypothesis (Schacter & Addis, 2007) proposes that the generation of novel future events relies on the extraction and flexible recombination of autobiographical memories. This would imply that people who have difficulties in recalling their personal past will also struggle to construct EFT.

Race, Keane and Verfaellie (2011) appear to be the first to document a correlational relationship between episodic memory and EFT. Participants' past and future event descriptions were rated according to the level of details given about spatial reference, entity presence, sensory description and the occurrence of any introspective thoughts, emotions or actions. They reported that eight amnesic patients with medial temporal lobe lesions provided less detailed narratives for events in both the near and distant future compared to matched controls. The patients' level of detail given in the past events were strongly correlated to the quantity of information described in the future events ($r = 0.75$). It was argued that the impoverished descriptions of MTT could not be explained by issues with working memory or the narrative demand of the task as the patients, when asked to tell stories following the presentation of a picture, were able to perform as well as the controls.

Further evidence for concordant deficits in autobiographical memory and future episodic thinking comes from Cole, Morrison, Barak, Pauly-Takacs and Conway (2016). They reported a single case study of a man with anterograde and retrograde amnesia following several cerebrovascular injuries. His EFT differed from health controls both in quantity, but also quality. Specifically, his outdated autobiographical knowledge appeared to be reflected in his EFT, leading him to construct future scenarios that would be implausible given his mental and physical health. Cole and colleagues (2015) suggested that EFT appears to occur within the boundaries of current autobiographical memory. Specifically, they argued that it is the type and number of episodic memories that an individual can recall that influences the content and amount of thoughts they have about experiencing events in the future (Cole et al., 2016).

2.1.4 The Differences between Episodic Memory and Episodic Future Thinking

"It seems that everyone remembers their best day, their worst day, and their yesterday. Because unusual events and recent events are so memorable, people tend to use them when constructing simulations of future events" (Gilbert & Wilson, 2007)

It appears that episodic memory and EFT are at least partially interdependent and engage overlapping neurocognitive systems. However, it seems there are some key differences between the cognitive processes. A future episodic thought differs from an episodic memory, as it has not already been constructed so cannot be recalled, but instead needs to be generated. This suggests that EFT may involve other cognitive and neural processes from those involved with episodic memory. It has been reported that the right frontopolar and left ventrolateral areas of the prefrontal cortex, the left parahippocampal gyrus and the right hippocampus are more active during future event construction (Addis et al., 2007, Addis & Schacter, 2008; Okuda et al., 2003; Szpunar et al., 2007). These

findings suggest that EFT construction involves greater cognitive effort than recall (Addis et al. 2007; Botzung et al., 2008).

2.1.4.1 The Reduced Detail in Episodic Future Thinking

Another frequently observed difference between past and future MTT is that imagined future events are typically described with less sensory detail then recalled autobiographical memories (Addis et al., 2008; Berntsen & Bohn, 2010; D'Argembeau & Van der Linden, 2004). The study conducted by D'Argembeau and Van der Linden (2006) involved 102 undergraduates recalling seven past and seven plausible future events. All participants completed the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) as a subjective measure of the clarity of mentally generated scenes. D'Argembeau and Van der Linden (2006) observed that the VVIQ significantly predicted the quantity of visual and sensory information described in both the past and future conditions. It also predicted the clarity of spatial context, emotions and personal saliency of future events. This suggests that the participants with more vivid visual imagery were able to conjure up past and future scenes with greater detail, not just visually, but using all senses.

D'Argembeau and Van der Linden (2006) also reported that the descriptions of EFT typically contained less temporal and spatial detail than past descriptions. Furthermore, it appears that the detail of the description of EFT decreased as the temporal distance from the present time increased (D'Argembeau & Van der Linden, 2004). Miles and Berntsen (2011) reported less vivid sensory descriptions in EFT that was occurring in the more distant future than those imagined closer to the present.

2.1.5 The Relationship between Schemas and Episodic Memory

Schema theory explains how knowledge is acquired, processed and stored (Bartlett, 1932). Schemas are units of knowledge that are organised within a network that evolves with experience (Piaget, 1952). Wadsworth (2004) uses the analogy of index cards in the

brain to explain how schemas assist memory recall and guide behaviour by providing a mental model of the world. Schema theory is considered to be the best supported theory that unites the cognitive processes of memory and imagination (Rubin, 2014). Bartlett's belief that memory is reconstruction influenced by attitudes from past experiences is at the core of Schacter & Addis' (2007) constructive episodic simulation hypothesis. Rubin (2014) postulates whether the reduction in the detail for EFT is due to it being generated from more abstract general schemata as opposed to being the consequence of recombined recollections.

2.1.6 The Activation of Schemas through Prompts: The Potential Benefits of Scaffolding

This paper considers whether MTT and specifically the scene construction necessary to support it can be enhanced through activating the relevant schemas. For example, when people are asked to tell a story, the challenge may be addressed by making use of a schema stored in semantic memory that guides the narrator to formulate a beginning, middle and end (Weaver, Mannes & Fletcher, 1995). Directed questions that elicit details on who is involved in a memory as well as what, where, when and why the scenario is occurring can provide further direction. The use of scaffolding does not appear to have been investigated in studies assessing patients with impaired episodic and future episodic thinking. It raises the question as to whether it could assist patients both recall events from their past as well as imagine plausible events in their future. If this scaffolding approach helps patients' performances on a MTT task, it would challenge the notion that their difficulties are mainly due to a failure of representation that precludes cohesive scene construction. Poor performance using word or picture cues to generate episodic memories and EFT may be due to executive difficulties with searching, planning and organising. Evidence that patients with frontal lobe lesions are impaired at EFT suggest that executive processing has a key role (Rasmussen & Bernsten, 2016). Providing patients with prompts may give them

the tools they need to search effectively through their autobiographical memories and select appropriate episodic events that form the foundations of past and future event descriptions.

2.1.7 The Importance of Scene Construction for Mental Time Travel

It has been proposed that the fundamental issue that amnesic patients have with MTT is the ability to imagine a comprehensive scene, which subsequently reduces the sense of autonoetic consciousness (Hassabis, Kumaran, Vann & Maguire, 2007; Race, Keane, Verfaellie, 2013). Hassabis and colleagues (2007) investigated whether there was a difference in the ability to construct novel, yet plausible, visual experiences amongst five amnesic patients with bilateral hippocampal damage compared with ten matched healthy controls. Participants were asked to imagine scenarios prompted by short verbal descriptions of a range of common situations. The task did not specify a time frame and because a temporal context was not assessed, it is unknown whether the participants imagined events in the present or the future. Whilst the amnesic patients did not significantly differ from the controls in their opinion of its difficulty, they did report fewer details in each of the rated categories. There was a notable difference in the reported descriptions of spatial coherence for the overall task between the two groups of participants, with the patients indicating that their imagined scenarios were experienced as a series of disconnected images.

These findings led Hassabis and colleagues (2007) to suggest that the hippocampus is a crucial part of the brain for the construction of visual imagination, in particular the integration of detailed descriptive, sensory, emotional and spatial information, that is a pre-requisite for MTT[6]. However, Squire et al. (2010) challenged this notion by reporting that

[6] Further support for the hippocampus providing a framework for the internal representation of imagined scenes has been described by Mullally, Intraub and Maguire (2012).

six amnesic patients (five with discrete hippocampal lesions and one with more extensive damage to the medial temporal lobe) were as capable in constructing future scenarios in response to cue words as healthy controls. Squire et al.'s (2010) results may have been influenced by the methodology; the researchers scored 'elements' which were pieces of information that included semantic detail, which has been shown to be intact in this patient population (Race et al., 2011). Additionally, they did not measure the level of spatial coherence, i.e. to what extent the participants' event visions formed a complete picture. One of the most prevalent explanations as to why amnesic patients struggle with MTT tasks is because they struggle to piece together episodic details as a result of these details being fragmented. A useful analogy of how an amnesic patient may experience MTT is to think of how a jigsaw puzzle would look like if some of the pieces were missing or damaged (Hassabis et al., 2007).

In summary, there is accumulating evidence suggesting that at least some patients with impaired episodic memory, arising from medial temporal lobe damage, are able to construct and describe novel visually imagined scenes. However, it seems that these patients' descriptions significantly differ in terms of their level of multi-modal detail and cohesiveness when compared with healthy controls (Hassabis et al, 2007; Race et al., 2013).

2.1.8 Study Objectives

This study investigates whether patients with significant and disproportionate impairments in retrograde memories, but in the context of relatively well preserved cognition, show similar patterns of impairment in EFT. It also explores whether deficits in MTT are due to executive difficulties. This is investigated through the use of scaffolding in the form of structured questions. These verbal prompts may assists amnesic patients by reducing demands on executive functioning skills.

If the difficulties that the patients experience with MTT are due to a core deficit in the representational content of the scenes generated by amnesic patients, then the use of prompts should not influence the level of detail provided for past or future event descriptions. If, however, their difficulties are due to a failure at the level of executive control over their endogeneous search and retrieval problem-solving strategies, then patients will benefit from scaffolding. It is anticipated that this will be even more prominent for EFT because it seems that future MTT is a more cognitively challenging process than recalling episodic memories and, therefore, may rely more on executive control than recalling past episodic memories.

2.1.9 Hypotheses

1. In line with previous research, it is hypothesised that all participants (both patients and neurotypical controls) will provide less detail in their unprompted future events than their unprompted past events.

2. In line with previous studies, it is hypothesised that patients with hippocampal lesions and reported impairment in their episodic memory will provide less detailed unprompted descriptions for both past and future events compared to the control group.

3. It is hypothesised that the patients will report less temporal, spatial, sensory and emotional detail in both their past and future unprompted MTT descriptions when compared to the control group.

4. It is hypothesised that scaffolding, through the provision of verbal prompts, will lessen the impact of executive demands on the MTT task for all participants. If, however, the patient's deficits in MTT are due to a loss of the internal

representation of spatially coherent scenes (e.g. Zeidman & Maguire, 2016), then the provision of verbal scaffolding should have no effect on the patients' responses.

2.2 Method

Prior to recruitment, ethical approval was obtained[7]. All participants were initially recruited to the Young Onset Dementia Assessment (YODA) study[8]. The University Hospital Southampton NHS Foundation Trust was the sponsor for this study.

2.2.1 Design

This study compared two single cases of neurological memory disturbance with a small opportunistic sample of neurotypical controls, who were approximately matched on relevant demographic variables. In the absence of a standardised MTT measure and population norms, a control group provides a baseline from which each patient's performance on the task could be compared in order to identify deficits with MTT. This study uses a method for single case designs described by Crawford and Howell (1998).

2.2.2 Participants

All patients over the age of 18, who are referred to the Cognitive Disorders team for evaluations, are routinely informed of ongoing internal and local research studies that are relevant to their condition. The YODA protocol makes it a pre-requisite that patients at

[7] Ethical approval was firstly obtained from the University of Southampton's School of Psychology Ethics Committee. As recruitment involved patients, further ethical approval was attained via the Integrated Research Application System. This study is considered a sub-study to YODA. Consequently, ethical approval was also obtained through an amendment to YODA's protocol and granted by the National Research Ethics Service (NRES) (Appendix B). Ethical approval covered, but was not limited to, appropriate indemnity and insurance.

[8] The YODA study is an observational, longitudinal, multicentre study without experimental treatment. It recruits patients with young onset dementia, as well as others with static brain injuries displaying cognitive impairment. Additionally, caregivers and healthcare professionals supporting these patients are recruited to provide insight into service provision and, where appropriate, to act as control participants.

the stage of recruitment have capacity to give informed consent and have not had a diagnosed pre-morbid intellectual disability. Participants, who were recruited to YODA, were selected to participate in this study between April and August 2015.

2.2.2.1 Patients

This study recruited patients with hippocampal pathology who had no other abnormalities present on their Magnetic Resonance Imaging (MRI) scans. These patients had documented persistent complaints of memory impairment following neurological illness or injury, but with minimal additional cognitive difficulties. The latter criteria was determined through screening patients' cognitive profiles obtained through the completion of the standard battery of Neuropsychology tests utilised within the department[9]. Four suitable patients were identified and informed of the study, but only two consented to take part in the YODA project and this sub-study. Both patients have very rare clinical presentations. Although they have similar structural pathology, their brain injuries have resulted from very different conditions.

2.2.2.1.1 Patient BG

Patient BG is a 59 year old married woman who had enjoyed good health prior to experiencing Voltage Gated Potassium Channel complex antibody Limbic Encephalitis (VGKC-LE) in 2007. She had worked as the financial director in a small business. After finishing secondary school, she completed a certificate in education and focused on raising her now adult daughters.

Patient BG's MRI scan (figure 3) shows bilaterally increased signal in the medial temporal lobes with a reduction in the volume of her hippocampus. These are

[9] These include measures of IQ, verbal comprehension, working memory, perceptual organisation, processing speed, verbal memory, recognition memory for words and faces, as well as assessments of executive function, attention, anterograde and retrograde memory

characteristics of chronic hippocampal sclerosis. She has experienced recurrent epileptic attacks, thought to occur in the frontotemporal region[10]. She appears to have responded well to a tailored course of Pregabalin; her seizures have reduced in frequency and severity since her diagnosis. They now take the form of occasional brief focal seizures which she reports are often accompanied by a sense of déjà vu.

Figure 3. MRI scan of BG (2008) depicting bilateral hippocampal atrophy

Since her illness, BG has impaired autobiographical memory that follows the pattern of an epileptic amnestic disorder. Her retrograde autobiographical memory is impaired across her whole lifespan, apart from one or two fragmentary events. For example, she cannot recall meeting her husband, but has an image of herself being walked up the aisle at her wedding. Her anterograde memory deficit has the characteristic of

[10] Patient BG's seizures appear to be triggered by the anti-glutamic acid decarboxylase (GAD) antibody which reduces the inhibitory neurotransmitter.

Accelerated Long-Term Forgetting (ALTF)[11]. In a clinical setting, it is reported that she is able to learn most forms of new information, but then forgets them abnormally quickly. For example, having spent hours with her clinical examiner, scoring within the normal range on clinical tests of memory, BG was unable to recall the entire event at her next appointment a few weeks later. During clinical testing when under pressure, it is noted that she occasionally fills the gaps in her memory by using plausible inferences and deductions.

Patient BG's performance on tests of general intellectual functioning, language and executive functioning demonstrated generally well preserved intellectual skills. A summary table of her most recent neuropsychological assessment scores are set out in Appendix F.

2.2.2.1.2 Patient TC

Patient TC is a 67 year old married woman. She had been a Physical Education teacher and subsequently the manager of a family business. She described herself as an intellectual, having completed a Master's degree. However, in 2010 she reported a decline in her cognitive and memory abilities following routine arthroscopic surgery on her knee. She was referred for a neurological opinion which concluded that she had most likely suffered a hypoxic episode whilst under general anaesthetic. A sequence of MRI scans demonstrated a unique focal bilateral and symmetrical volume loss in the anterior hippocampi (figure 4).

Patient TC described feeling very frustrated about her significant retrograde memory loss for autobiographical events. She explained how she had been compensating

[11] This is a syndrome which affects autobiographical and other types of events. It is characterised by an unusually rapid loss of recently learned material despite a normal learning process and an initial level of retention (Fitzgerald, Mohamed, Ricci, Thayer & Miller, 2013).

for her difficulties by re-learning information with the support of her family. Aside from difficulties with location learning and egocentric navigation, her anterograde memory appeared to be within the average range. Her performance on general intellectual functioning, language skills and executive functioning did not identify any substantial deficits in these areas. Since 2010, her neuropsychological profile has remained constant. A summary table of her most recent neuropsychological assessment scores are set out in Appendix G.

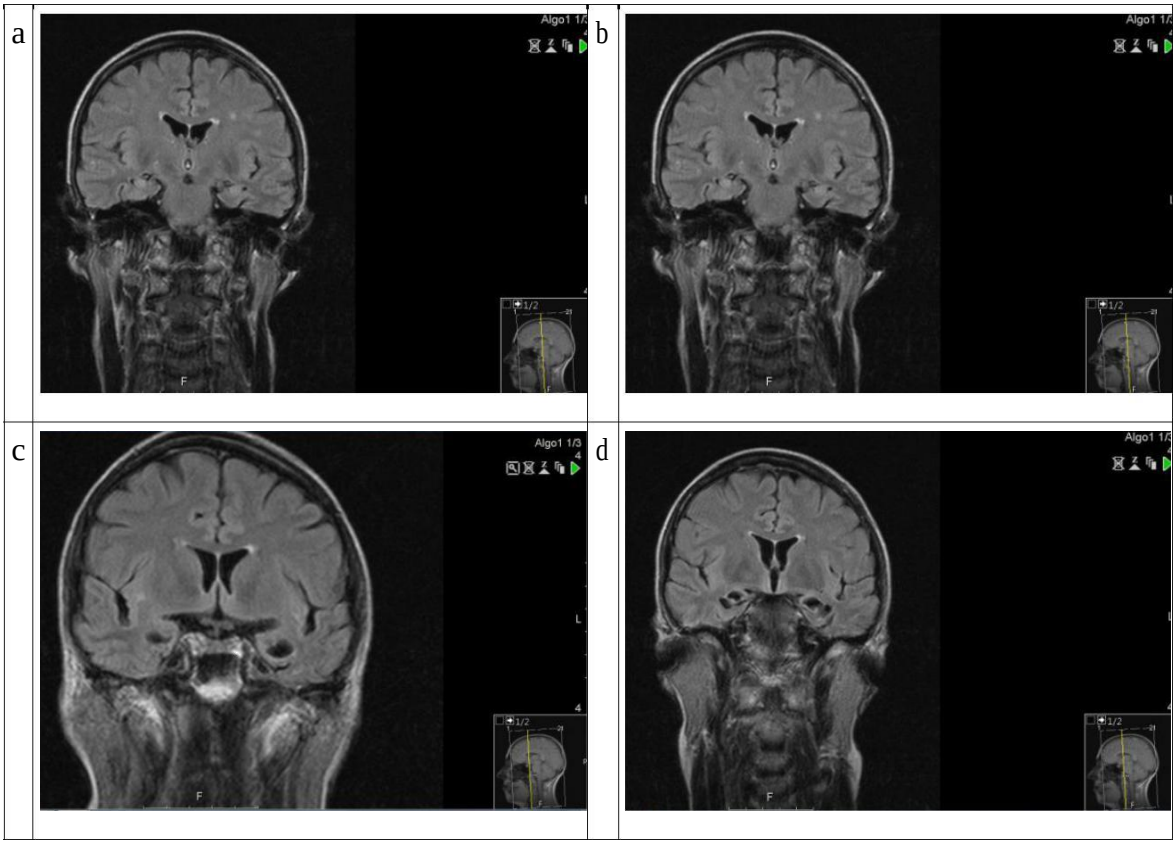

Figure 4. Sequence of MRI scans for Patient TC
The middle-posterior hippocampus is shown in slides a and b. The anterior hippocampus with circumscribed injury in slides c and d.

2.2.2.2 Control Group

An invitation letter (Appendix H) was sent to an opportunistic sample of 11 healthy volunteers, seven of whom responded. They all confirmed during a follow-up telephone call that they were not experiencing any current significant physical health issues or memory difficulties. Written consent was obtained, with five completing the task following

further suitability assessment.[12] Aside from gender, the patients were well matched to each participant in the comparison group on demographic data, with no significant differences. All participants reported that English was their native language and they were of Caucasian ethnicity. The control group consisted of two females and three males. Their ages ranged from 43 to 69 years (M = 57.6 years, SD = 9.48). Their level of education ranged from 13 to 17 years (M = 14.8 years, SD = 2.04).

2.2.3 Procedure

All potential participants were given the Participant Information Sheet (PIS) (Appendix C) to read at least 24 hours in advance of obtaining their informed consent to participate. The PIS summarised the study's aim and procedure, the advantages and disadvantages of participation and how personal data would be stored.[13] Both the PIS and Consent Form[14] (Appendix D) stated that all participation was voluntary; participants could withdraw at any time without giving any reason[15]. The Debriefing Form (Appendix E) provided contact details for psychological support in case participation caused unanticipated emotional distress.

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[12]Two participants were excluded on the grounds of not meeting the criteria for good health. These included any history of head injury, neurological conditions or cardiovascular events. One participant had had a childhood head injury, the other had had a recent transient ischaemic attack

[13]It confirmed that all participants' audio recordings would be saved onto an encrypted data stick until transcribed anonymously by an assistant and subsequently deleted. All completed inventories would be anonymised through the allocation of a numerical code and stored securely within the Hospital. It also stated that personal information would be recorded on an electronic database, access to which would be restricted to the research team through their personal hospital generated logins and pin codes. Participants were assured that what they disclosed would be kept confidential.

[14]Prior to obtaining written consent, it was confirmed that all participants had had sufficient time to read and understand the information sheet and had been provided the opportunity to ask any questions. Participants were given a copy of their consent form.

[15]These forms also assured participants that declining to take part would not impact on any medical care they may receive or their continued participation in the main YODA study.

Participants were tested individually in their home and were offered regular breaks to reduce fatigue. A registration sheet (Appendix I) and pre-assessment form (Appendix J) was completed to obtain demographic data and basic medical history. All participants were asked to provide a subjective rating of their current overall physical and mental wellbeing on a scale of 0 to 10, where 10 represented optimum wellbeing. Participants who gave a rating of at least seven were considered to be in reasonable health and eligible to participate, providing they did not disclose any significant medical issues. Participants completed four screening measures before completing the main word cue task.

2.2.3.1 Screening Measures

The National Adult Reading Test (NART; Nelson & Willison, 1991) is a widely used reading test to establish levels of premorbid crystallised intellectual ability, as it is quick and easy to administer (Bright, Jaldow & Kopelman, 2002). This measure was chosen as it provides an estimate of optimum IQ as performance does not appear to be overly affected by neurological insults (Watt & O'Carroll, 1999). Estimates of internal consistency are above .90 and test-retest reliability after a year is high (.89) (Strauss, Sherman & Spreen, 2006). It also has high interrater reliability (Riley & Simmonds, 2003) and a good level of accuracy in predicting verbal and full scale IQ scores determined by the Weschler Adult Intelligence Scale (WAIS-III; Weschler, 1997). It requires participants to read aloud 50 words that do not follow usual rules of pronunciation. (Appendix K).

The Advanced Progressive Matrices (APM; Raven, Raven & Court, 1998) are a well-utilised non-verbal reasoning task that provides a good estimate of current fluid intelligence.[16] It assesses individual cognitive processing, specifically analytical ability and is considered an index on executive functioning (DeShon, Chan & Weissbein, 1995).

[16] Raw scores are transformed into scaled scores and percentiles (Warrington, 1984).

Matrix reasoning is likely to be one of many crucial cognitive abilities required for MTT. This was chosen alongside the NART because significant disparity between scores on the NART and APM can be sensitive to early stages of cognitive decline, particularly in visuo-spatial abilities (Sattler & Ryan, 2009; van den Berg et al., 2013)[17]. It has high re-test reliability (>.80) and moderately strong correlations (between .40 and .75) with the Weschler Adult Intelligence Scale (WAIS-III; Weschler, 1997) Participants are required to identify the missing element from a series of options to complete a pattern.[18]

The Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) is a self-reporting measure assessing individual differences in the vividness of mental imagery (Appendix L). This measure was chosen to evaluate the participants' ability to form clear visual images of topics that were not dependent on MTT in order to identify participants who may have aphantasia, an impairment in this cognitive ability (Zeman, Dewar & Della Sala, 2015). Whilst there have been some concerns regarding whether this inventory is also measuring imagery control and could be vulnerable to social desirability bias (Childers, Houston & Heckler, 1985) it has been found to have an adequate test-retest reliability for the entire scale of .73 (Rossi, 1977) and appears to be the best published measure of vividness for visual images currently available. Participants are asked to consider four scenarios without specific temporal content and to construct a picture in their minds. They are subsequently asked to rate their level of detail for four aspects of each scenario, using a

[17]The gender specific multiple linear regression equations cited by van den Berg et al. (2013) were used to calculate the estimated APM score for each participant. An APM discrepancy score was computed by subtracting the estimated score from the observed score. Significant impairment on the APM was identified if the discrepancy score was below the 16th percentile distribution (1 standard deviation below the mean) (van den Berg et al., 2013).

[18]There are two sets of tasks, which each task becoming progressively harder (Raven et al., 1998). There is growing evidence to suggest that administering set I of the APM, consisting of 12 items, is just as reliable and valid as all 48 tasks (Chiesi, Ciancaleoni, Galli & Primi, 2012). Therefore, in order to reduce participant fatigue, only set I of the APM was used.

five point Likert scale. Lower scores equate to greater subjective reports of vividness of mental imagery.

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) is a screening tool for general psychological distress (Appendix M). This is an extensively used self-reporting state measure inventory, both clinically and in research (NHS Quality Improvement Scotland, 2011). It has strong validity and reliability for the general population (Bjelland, Dahl, Haug & Necklemann, 2002) and good internal consistency (Mykletun, Stordal & Dahl, 2001). This screening tool was chosen as there is considerable evidence to suggest that the recall of episodic memories is adversely affected by emotional distress (Williams et al. 2007). It was chosen over other depression and anxiety measures as it excludes symptoms that often overlap in physical health conditions and is able to distinguish between symptoms of these mood disorders (Snaith & Taylor, 1985). It consists of 14 questions assessing symptoms of depression and anxiety.

2.2.3.2 The Mental Time Travel (MTT) Task

All participants engaged in two task conditions: these were recalling and describing events from their past and imagining events they could potentially experience in their future. The MTT task was developed by the experimenter. This was based on earlier work conducted by Addis and colleagues' (2008), who used the Galton-Crovitz-Schiffman cue-word technique (Crovitz-Schiffman, 1974; Galton, 1879) as a random sampling method. Participants were encouraged to think about an event that came to mind following the visual and auditory presentation of a cue word. Each cue word was used in both the past and future conditions. The words were selected from a pool of commonly used four letter abstract and concrete words, selected for their familiarity and anticipated neutrality (Brown & Ure, 1969). Each word was presented one at a time, remaining in view for the duration

of the event description. The cue words were presented using an ABBA design in order to counterbalance practice effects (Appendix O).

In both past and future conditions, participants were asked whether they were happy to discuss the event that had come to mind. They were encouraged to build up the detail of the scenario before describing it for up to two minutes. They were assured that it did not matter if they were describing an important or trivial scenario, but it was important that they were describing a single occurrence. When recalling past events, participants were asked to report to the best of their ability as much detail as possible, but without elaborating on the truth. When describing future events, participants were instructed to not knowingly describe any part of a past event, but to allow their imagination to create a novel, plausible scenario. Each participant received the same instructions (Appendix N).

To assist the participants' understanding of what was expected, a scripted example of a past event prompted by the cue word 'pond' was given (Appendix N). This description included details of what the event was, who had been present, where, when and why the event had taken place as well as some sensory and emotional details. Participants were given no additional prompts and allowed to talk freely. Following a pause of more than 10 seconds, or when the participant had spoken for two minutes, a predetermined list of questions was used to prompt them to elaborate on their descriptions. The questions stem from the author Rudyard Kipling, who described his narrative technique for ascertaining a complete story (Kipling, 1902):-

1. Who is present in the scenario?
2. What happened/will occur?
3. When is the memory/imagined event taking place
4. Where is the event taking place?
5. Why did this recalled event/imagined event occur?

Two further questions were asked to explore whether participants were able to give sensory and emotional details. These were:-

6. Are there any sensory details? (Visual, olfactory, auditory, tactile or gustatory perceptions)
7. Are there are any emotions associated with this event?

When participants had finished their prompted descriptions, they were asked to rate on a scale of 0-10 how much it felt like they had mentally travelled in time to experience each event described. This question provided a subjective measure of autonoetic consciousness. They were also asked to rate on the same scale how clear the picture was in their mind's eye. This provided a subjective measures of vividness of their mental imagery.

2.2.4 Data Analysis

2.2.4.1 Preparing the Data

All descriptions from the task were annotated by the experimenter on the anonymised recordings sheets (Appendix P) during testing and subsequently checked against the transcripts[19]. This qualitative information was then converted into quantitative data through the allocation of numerical scores. A score of one to three was given for the level of detail within the following seven categories; who, what, where, why, when, sensory and emotion. A score of one was given when no detail was provided. A score of two was awarded for some detail provided in the category and a score of three was given for full detail. In order to make the scoring procedure objective and replicable, it was necessary to clarify what would constitute partial and full detail. Three points were awarded when the participant described more than one entity. For example, a narrative that included a season and a time would be given three points in the 'when' category. Whereas

[19] Excerpts from each patient's transcripts are provided in Appendix Q and R.

the description of an object or scene that included a colour but with no other sensory input would be awarded two points in the 'sensory' domain.

A second rater, who did not have sight of the experimenter's ratings and was unaware of the experimental hypothesis, scored each of the categories on all the participants' sheets in the chronological order in which the participants took part. The order of the participants' twelve task sheets was randomly distributed. In order to calculate scores, they were provided with copies of the transcripts and blank recording sheets. These ratings were then compared with the experimenter's ratings. There were only five out of 420 occasions where there was an initial discrepancy in scores. These related to whether a category should be awarded two or three points for the level of detail provided. With all of these instances, discussion was undertaken in order to review the transcripts, scoring guidelines and the number of entities evaluated until a consensus was achieved.

The next stage of analysis involved comparing the patients' and controls' aggregated scores derived from their unprompted descriptions obtained from the six cue words in the past and future conditions. Further analysis involved looking at how each patients' scores differed from the control scores with regards to level of detail across three domains that are salient in episodic and semantic memory. The functional domain was the combination of the 'what' and 'why' scores. The temporal-spatial domain consisted of the 'where' and 'when' scores. Both of these domains rely on objective and concrete details. The sensory-emotion domain was a combination of the sensory and emotion scores, which reflects endogeneous subjective experiences that are likely to be intrinsic to the sense of autonoetic consciousness (Ingvar, 1985). The final stage of analysis focused on whether there were significant differences between the patients and controls in their autonoetic and clarity ratings.

2.2.4.2 Statistical Analysis

Analysis of the control group provided a baseline against which it was possible to compare each patient's performance on the MTT task in turn (Crawford & Howell, 1998). The controls' total scores for each condition were analysed using a two way within subjects repeated measures ANOVA. The factors were temporal condition (past versus future) and type (unprompted versus prompted).

Due to a small control sample size, each patient's data was individually compared against the control sample using the SINGLIMS_ES.exe program. This program, originally developed by Crawford and Howell (1998), offers a classical hypothesis test designed specifically for use in a case-controls design (when comparing a single case to a control group[20]) (Crawford, Garthwaite & Porter, 2010). The statistical method is a modified t-test that determines whether a patient's performance on a task shows a statistically significant deficit when compared with a small control group[21]. It presents a point estimate of the abnormality of the individual's score compared with a control group (where $n < 50$). It also provides confidence limits on the abnormality of an individual's score through making use of a non-central *t* distribution. Lastly, it calculates an effect size, z_{cc} [22] with a 95% confidence interval.

The patient's total scores on the MTT task were also compared with the control group data using the Revised Standardized Difference Test (RSDT) program (Crawford &

[20] Crawford and Howell (1997) describe how "the sample size of the control or normative group recruited for comparison purposes in such [single case] studies is typically less than 10 and often less than 5" (p.483).

[21] This analysis differs from methods that uses z scores, as it handles the control group's data as statistics instead of parameters. This enables the control of type I error rates irrespective of the size of the control group (Crawford & Garthwaite, 2012).

[22] This is an estimate of the average difference, measured in standard deviation units, between a case's score and the score randomly chosen from one of the control group. This index is insensitive to the size of the control group.

Garthwaite, 2005). This test utilises classical methods to compare the differences in the difference between the performance on two tasks (i.e. past and future condition) between a single case's score and a control sample. This analysis would identify any dissociations in the patient's performance, i.e. whether any impairment noted in the past condition is equally evident in the future condition (Crawford, Garthwaite & Gray, 2003).

2.3 Results

2.3.1 Matching of controls and patients on demographic and screening measures

Demographic and questionnaire data for each of the patients, along with the corresponding means from the control group, is set out in Table 4. The control group's mean screening measures were all within normal ranges[23]. There were no statistically significant differences between the controls and either of the patients.

Table 4

Patients' and Controls' Demographic and Questionnaire Data

	Gender	Age	NART	NART	APM		HADS		Wellbeing	VVIQ
			Error	P. IQ	SS	%	A[24]	D		
Controls		57.6	14.8	108.2	13.2	75-95	3.6	1.2	8.4	29
TC	F	66	13	110	15	95	12	1	10	29
BG	F	59	9	114	>15	>95	6	3	9	22

Note. P.IQ = Predicted IQ. SS= scaled scores. % = percentiles.

[23]Demographic and questionnaire data for each of the controls is presented in Appendix T.

[24]One of the control's and patient TC scored 12 on the anxiety sub-scale of the HADS, which is within the moderate range (Zigmond & Snaith, 1983) and falls within the 10th percentile (Crawford, Henry, Crombie & Taylor, 2001). However, on the day of testing both participants reported scores on the informal subjective wellbeing scale that were above the required threshold to continue with testing.

2.3.2 Performance on the Mental Time Travel (MTT) task

There were five occasions (out of 84) when either a patient or a control did not give a description for an event following a word cue.[25] One of the controls did not describe a future event prompted by the cue word 'rude'. Another control did not describe a past event relating to the cue word 'free'. Patient TC did not provide descriptions for two future scenarios; this was following the presentation of the words 'lamp' and 'kite'. Patient BG did not provide a description for a future event prompted by the word 'cork'. Supplementary information on the type of events described by the patients and controls is presented in Appendix S.

2.3.3 Statistical Analysis

The control's data was analysed using a 2 way within subjects repeated measures ANOVA. The main effects of temporal condition (past versus future) and type (unprompted versus prompted) were both significant ($F_{(1,4)} = 5.757$, $p = .074$, $n_p^2 = 0.59$) and ($F_{(1,4)} = 353.91$, $p < .001$, $n_p^2 = 0.99$), respectively; see Table 5. Controls provided significantly more detailed descriptions for their past events than their future events. Their event descriptions after prompting were also significantly more detailed than their unprompted ones. The interaction between time and type was also significant ($F_{(1,4)} = 28.9$, $p = .006$, $n_p^2 = 0.88$). The controls provided less detail in their unprompted future descriptions than their unprompted past ones.

[25] The mean control group's response rate was 96.67%. Patient TC's response rate was 83.33% and BG's response rate was 91.67%.

Table 5.

The Control Group's Mean Total Scores in Each Condition of the MTT task

Condition	μ Total Score	*SE*	CI
Past Unprompted	94.8	3.48	85.13 – 104.47
Past Prompted	116.4	3.17	107.60 – 125.21
Future Unprompted	69.4	8.62	45.46 – 93.34
Future Prompted	108	6.22	90.73 – 125.27

Note. μ = mean. SE= standard error. CI = 95% confidence interval.

As described above, each patient's data was then individually compared with the control group's mean scores[26] using the Singlims_ES.exe and RSDT_ES.exe programs developed by Crawford and colleagues for case-control design (Crawford, Garthwaite & Porter, 2010). In order to reduce type 1 errors, the two tailed p values were reported. As these are pairwise analyses, Bonferroni corrections were made to correct for multiple comparisons (Dunn, 1961)[27].

2.3.3.1.1 Patient BG

2.3.3.1.1.1 Investigating the Differences between Past and Future Descriptions and the Benefits of Prompting

When compared with the control group, the level of detail that BG provided for her past and future event descriptions was reduced. This was most noticeable in her unprompted past event descriptions, all of which were worse than the poorest control, a difference that was statistically significant before the Bonferroni correction was applied (Figure 5 & Table 6). Analysis of the differences across past and future conditions between

[26] It is difficult to identify outliers in very small samples. Therefore, as advocated by Barnett and Lewis (1994), all data obtained from the five controls were included in the robust statistical analysis.

[27] In order for a value to reach significance, probability scores needed to be <.0125.

BG and the controls shows a significant difference in the reduced detail for unprompted event descriptions in the past compared with the future (Figure 6 & Table 7). In summary, BG's unprompted descriptions tended to be more impoverished than the controls, particularly those for past events. However, she was able to make use of prompts in both conditions.

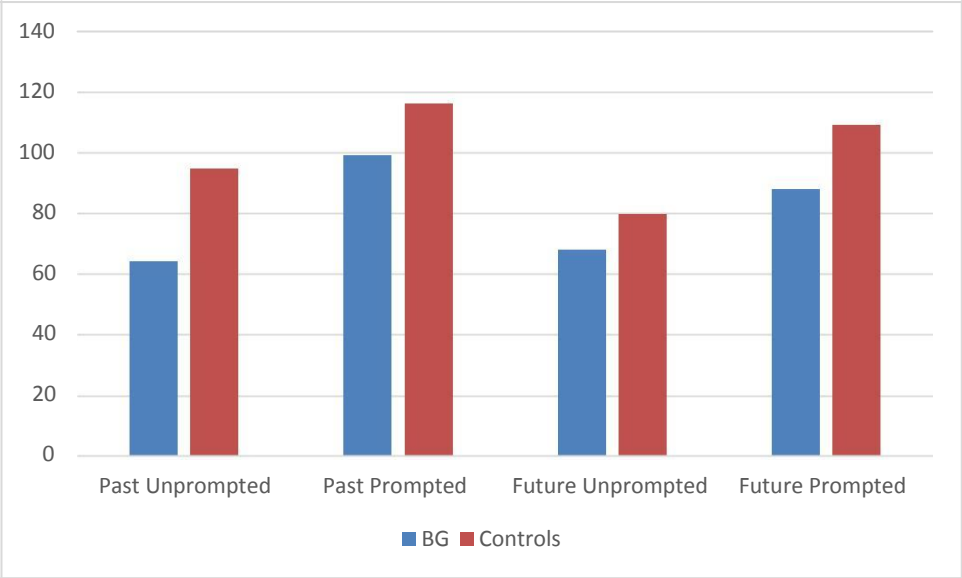


Figure 5. Patient BG's Total Scores in Each Condition Compared with the Control Group

Table 6.

Patient BG's Total Scores in Each Condition Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
Patient BG	64	99	68	88
Control *μ*	94.8	116.2	76	109.2
Control *SD*	7.76	6.91	13.13	11.48
t	-3.62	-2.27	-0.56	-1.69
p	.022*	.086	.604	.167
%	1.11	4.28	30.19	8.36
95% CI	0.00 – 11.41	0.00 – 27.39	5.99 – 64.87	0.04 – 37.87
Z_{cc}	-3.97	-2.49	-0.61	-1.85
95% CI	-6.75 - -1.21	-4.34 - -0.60	-1.56 – 0.38	-3.33 - -0.31

Note. * $p<.05$. μ = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

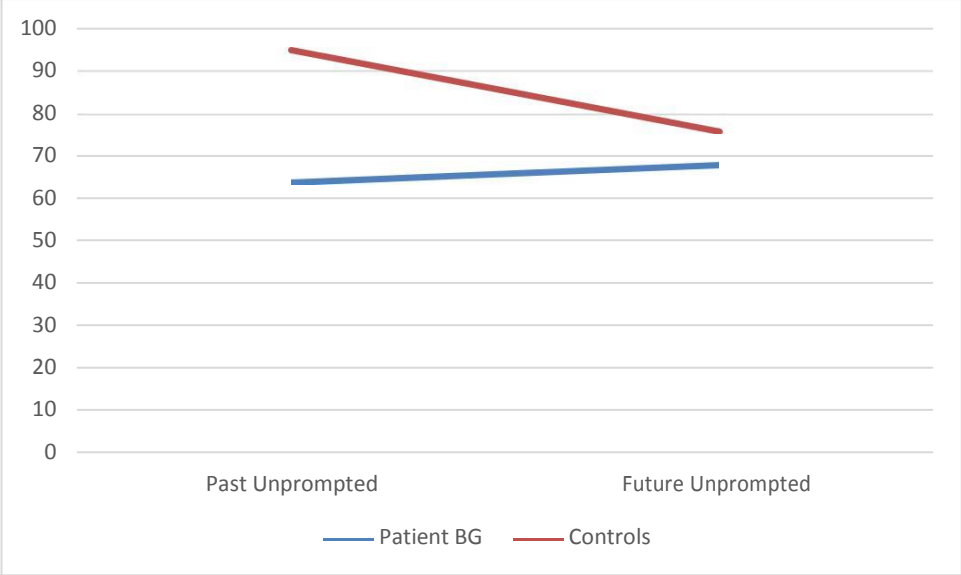


Figure 6. Patient BG's Total Unprompted Scores Compared with the Control Group

Table 7.

Patient BG's RSDT Analysis

	t	*df*	*p*	Z_{dcc}
Unprompted	3.090	4	.037*	-4.86 (CI -9.40 - -1.51)
Prompted	0.515	4	.317	-0.70 (CI -2.90 – 1.27)

Note. * p <.05. t = RSDT statistic. p = probability. Z_{dcc} = effect size. CI = 95% confidence interval.

2.3.3.1.1.2 Investigating the Level of Detail in Event Descriptions across Domains

The next stage of analysis looked at the level of detail provided in BG's descriptions across the three domains (functional, temporal-spatial and sensory-emotion). The results are presented in Figures 7 and 8 and Tables 8-10. There was a strong trend for BG's unprompted past descriptions to incorporate less functional and temporal-spatial information compared to the controls. Although her scores were worse than the poorest control, the difference did not survive Bonferroni corrections. Across the domains, BG gave the least amount in the sensory-emotion domain. There were no significant differences between BG and the controls in the level of detail across any of the domains for her unprompted future descriptions. This suggests that BG's difficulty with MTT is not bi-directional.

When investigating the benefits of prompts, the functional information in both BG's past and future prompted descriptions improved to a level similar to the controls. She also appeared to benefit from prompting for temporal and spatial detail information in her past descriptions. However, in the future prompted condition there was a significant difference in the temporal-spatial domain, prior to Bonferroni corrections. This result suggests that whilst she was able to give a comparable level of temporal and spatial detail to the controls

in her unprompted descriptions, this is a domain that she is not able to elaborate further on. Following prompts, BG also struggled to add further sensory and emotional information in both conditions. However her overall prompted scores in this domain did not significantly differ to the control group.

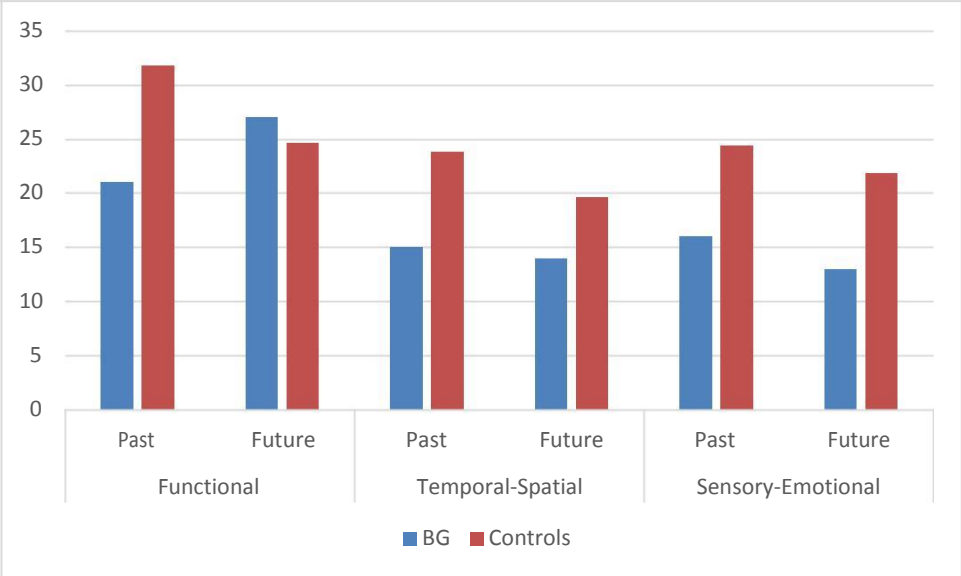


Figure 7. *Unprompted Description Scores for Each Domain: Patient BG Compared with Controls*

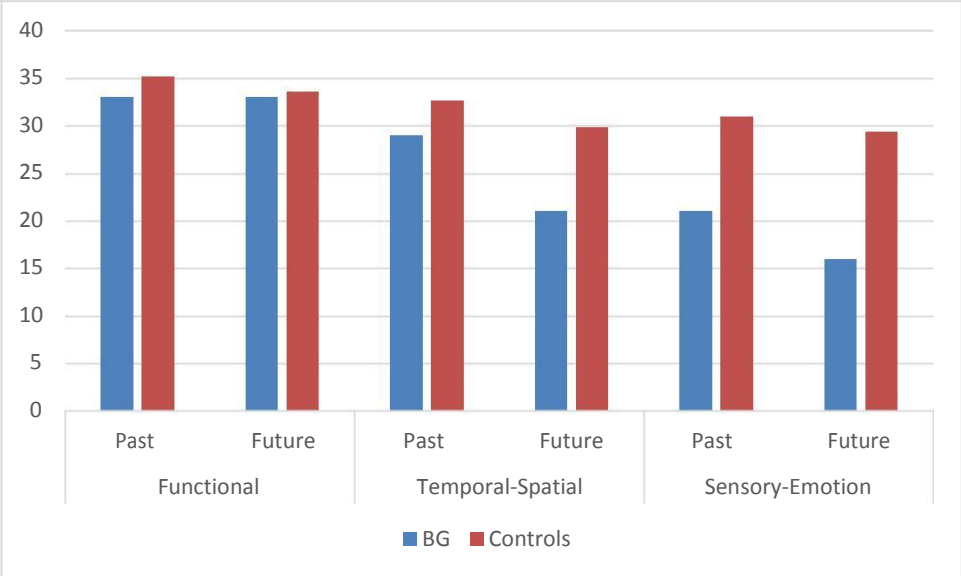


Figure 8. *Prompted Description Scores for Each Domain: Patient BG Compared with Controls*

Table 8.

Patient BG's Functional Domain Scores Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
BG's Score	21	33	27	33
Control *μ*	31.8	35.2	24.6	33.6
Control *SD*	3.56	0.84	4.39	3.05
t	-2.769	-2.391	0.499	-0.180
p	.050*	.075	.644	.866
%	2.52	3.75	67.80	43.31
95% CI	0.00 – 20.29	0.00 – 25.55	33.34 – 92.91	14.20 – 75.84
Z_{cc}	-3.03	-2.62	0.55	-0.20
95% CI	-5.22 - -0.83	-4.55 - -0.66	-0.43 – 1.47	-1.07 – 0.70

Note. * $p<.05$. *μ* = mean. *SD* = standard deviation. *t* = Crawford statistic. p = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

Table 9.

Patient BG's Temporal-Spatial Domain Scores Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
BG's Score	15	29	14	21
Control *μ*	23.8	32.6	19.6	29.8
Control *SD*	1.92	1.52	5.27	2.39
t	-4.184	-2.162	-0.970	-3.361
p	.014*	.100	.387	.028*
%	0.69	4.83	19.35	1.41
95% CI	0.0 – 7.48	0.00 – 29.18	1.56 – 54.02	0.00 – 13.73
Z_{cc}	-4.58	-2.37	-1.06	-3.68
95% CI	-7.76 - -1.44	-4.15 - -0.55	-2.16 – 0.10	-6.28 - -1.09

Note. * $p<.05$. *μ* = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

Table 10.

Patient BG's Sensory-Emotion Domain Scores Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
BG's Score	16	21	13	16
Control μ	24.4	31	21.8	29.4
Control *SD*	4.72	5.05	6.53	5.59
t	-1.625	-1.808	-1.23	-2.188
p	.180	.144	.286	.094
%	8.98	7.25	14.3	4.69
95% CI	0.06 – 39.11	0.02 – 35.50	0.51 – 47.71	0.00 – 28.75
Z_{cc}	-1.78	-1.98	-1.35	-2.40
95% CI	-3.22 - -0.28	-3.54 - -0.37	-2.57 - -0.06	-4.20 - -0.56

Note. *μ* = mean. SD = standard deviation. t = Crawford statistic. p = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

2.3.3.1.1.3 Autonoetic and Clarity Ratings[28]

The analysis of BG's mean autonoetic and clarity ratings is compared with the mean ratings from the control group in Table 11. Whilst her mean autonoetic ratings were lower in both the past and future conditions than the control group, they did not significantly differ. Her mean clarity ratings in both conditions were fairly similar to the mean control group. These results suggest that BG felt reasonably able to mentally time travel in both directions and generate coherent scenes in her mind.

[28] As BG did not provide a description or rating following the presentation of the cue word cork in the future condition, the corresponding control data was removed for this analysis

Table 11.

Patient BG's Autonoetic and Clarity Ratings Compared with the Control Group

	Past		Future	
	Autonoetic Rating	Clarity Rating	Autonoetic Rating	Clarity Rating
BG μ	30	50.5	14	38
Control μ	50.2	53.8	41.8	44.6
Control *SD*	8.41	8.01	11.50	10.53
t	-2.193	-0.38	-2.207	-0.572
p	.093	.726	.092	.600
%	4.68	36.30	4.60	29.89
95% CI	0.00 – 28.68	9.54 – 70.16	0.00 – 28.44	5.84-72.35
Z_{cc}	-2.40	-0.41	-2.42	-0.63
95% CI	-4.20 - -0.56	-1.31 – 0.53	-4.23 - -0.57	5.84 – 64.61

Note. μ = mean. *SD* = standard deviation. *t* = Crawford statistic.
p = probability. % = estimated % of norm population falling below individual score.
CI = confidence interval. Z_{cc} = effect size.

2.3.3.1.2 Patient TC

2.3.3.1.2.1 Investigating the differences between past and future descriptions and the benefits of prompting

The level of detail that TC provided in her descriptions of past events was almost indistinguishable from the controls. Consequently, there were no significant differences between her total scores and the control group. Her descriptions of future events were numerically less detailed than the control group, particularly so in the prompted condition. However, this difference narrowly missed statistical significance (Figure 9 & Table 12). Analysis of the differences across past and future conditions between TC and the controls showed a trend towards significance for the prompted descriptions, but not so for the unprompted descriptions (Figure 10 & Table 13). In summary, both the control group and TC found it easier to provide

more detailed descriptions for past events than future events. The control group were able to elaborate on their past and future descriptions with the provision of prompts. However, TC was only assisted by prompts in the past condition. Her future event descriptions did not benefit from prompting.

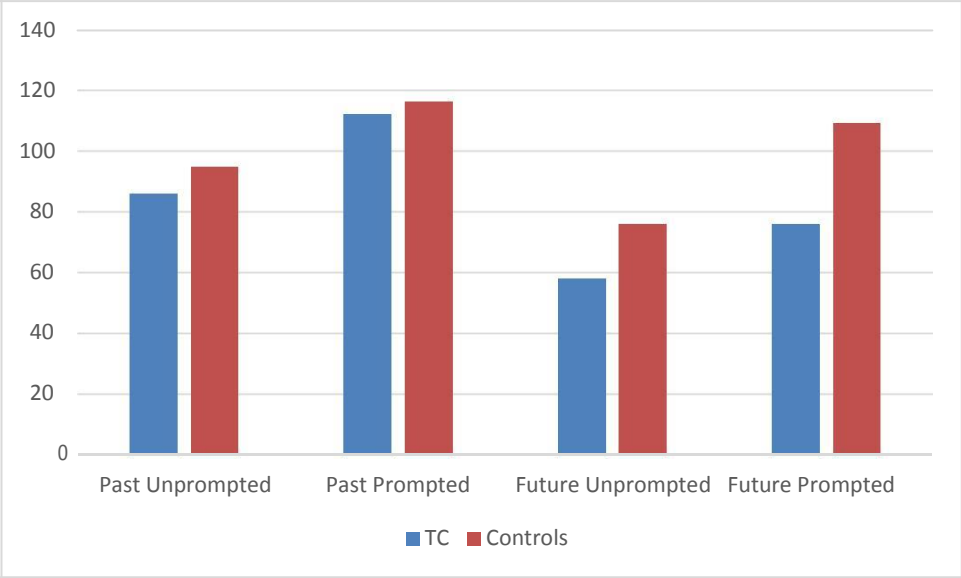


Figure 9. Patient TC's Total Scores in Each Condition Compared with the Control Group

Table 12

Patient TC's Total Scores in Each Condition Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
Patient TC	86	112	58	76
Control *μ*	94.8	116.2	76	109.2
Control *SD*	7.76	6.91	13.13	11.48
t	-1.04	-0.55	-1.25	-2.64
p	.359	.609	.279	.058
%	17.95	30.43	13.95	2.88
95% CI	1.20 – 52.40	6.12 – 65.09	0.46 – 47.22	0.00 – 21.99
Z_{cc}	-1.13	-0.61	-1.37	-2.89
95% CI	-2.26 – 0.06	-1.55 - -0.39	-2.60 - -0.07	-4.99 - -0.77

Note. *μ* = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

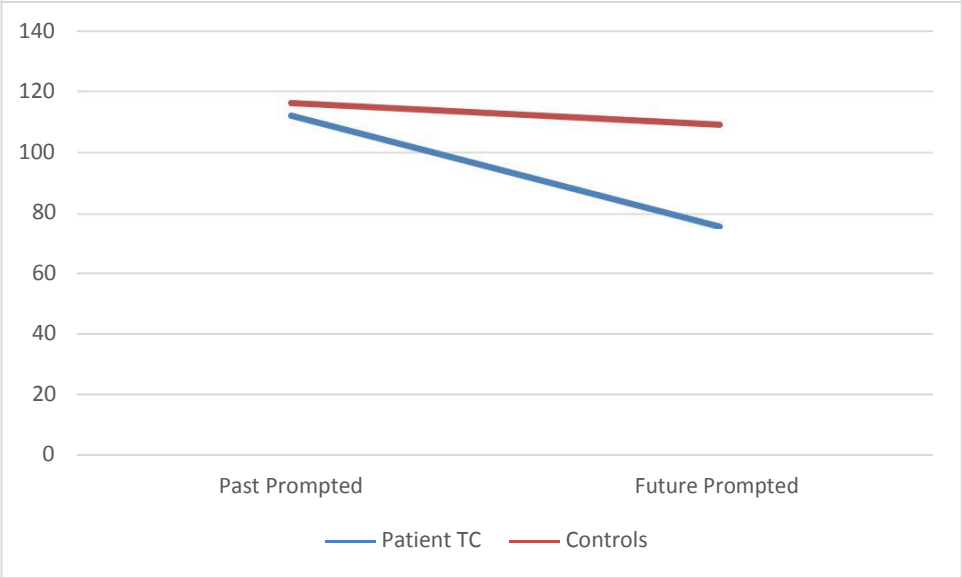


Figure 10: *Patient TC's Total Prompted Scores Compared with the Control Group*

Table 13.

Patient TC's RSDT Analysis

Condition	*t*	*df*	*p*	Z_{dcc}
Unprompted	0.247	4	.817	0.34 (CI -1.06 – 1.83)
Prompted	1.769	4	.076	2.492 (CI 0.45 – 5.23)

Note. *t* = RSDT statistic. *p* = probability. Z_{dcc} = effect size. CI = 95% confidence interval.

2.3.3.1.2.2 Investigating the Level of Detail in Event Descriptions across Domains The next stage of analysis looked at the level of detail provided in TC's descriptions across the three domains (functional, temporal-spatial and sensory-emotion). The results are presented in Figures 11 and 12 and Tables 14-16. When reviewing TC's unprompted past descriptions, it is evident that the amount of functional information was comfortably within the range of the control group and indeed exceeded their mean score. Following prompts, her past descriptions have a similar level of detail to the control group across all

three domains, suggesting that she is able to utilise prompts well. Patient TC's difficulty in providing further detail for her prompted future descriptions appears to be limited to the functional and temporal-spatial domains. However, none of these differences between her scores in these domains and the control groups' are statistically significant after the application of Bonferroni corrections. The only other contrast that approached, but did not reach significance, was TC's reduced temporal-spatial detail in her unprompted past event descriptions when compared with the controls.

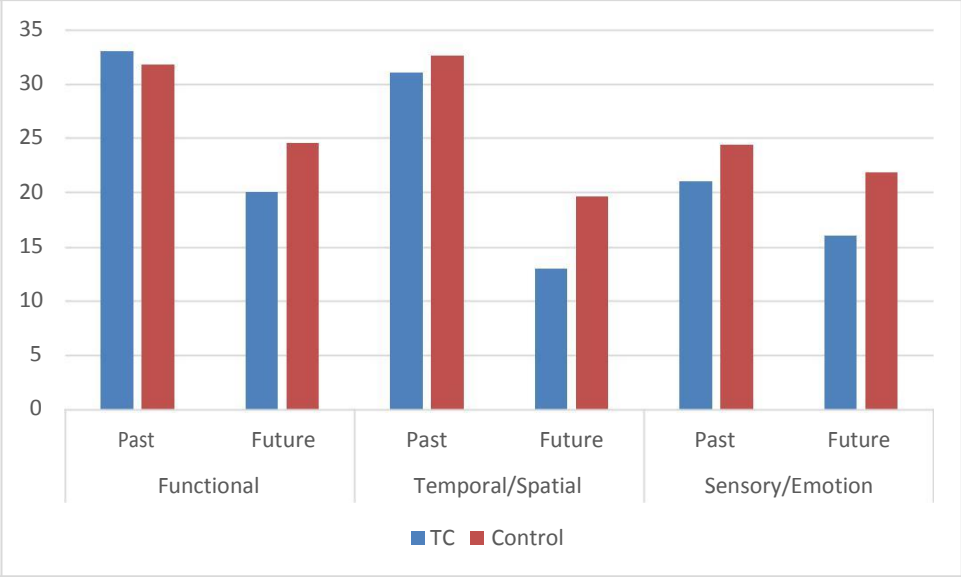


Figure 11. Unprompted Description Scores for Each Domain: Patient TC Compared with the Control Group

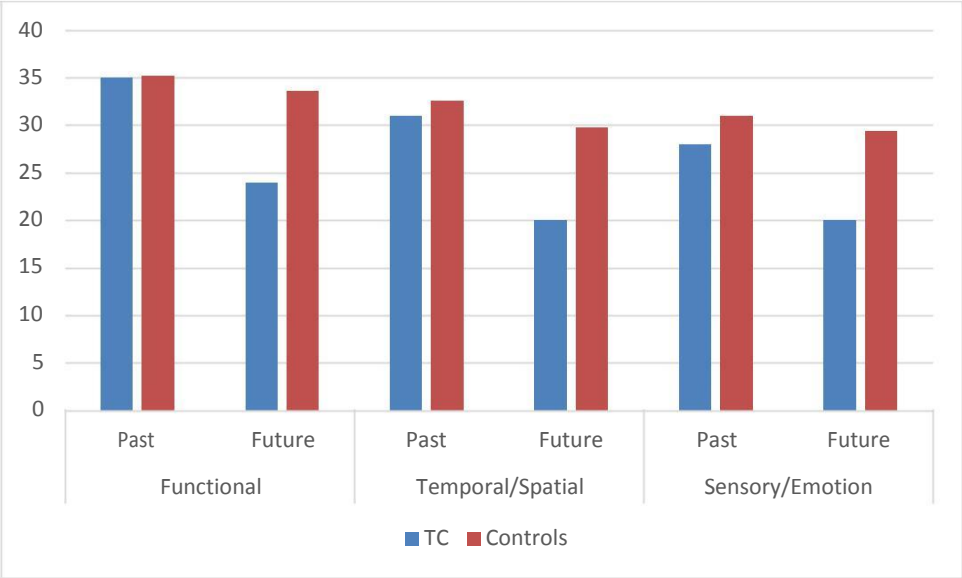


Figure 12. Prompted Description Scores for Each Domain: Patient TC Compared with the Control Group

Table 14

Patient TC's Functional Domain Scores Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
TC Score	33	35	20	24
Control μ	31.8	35.2	24.6	33.6
Control *SD*	3.56	0.84	4.39	3.05
t	0.308	-0.217	-0.957	-2.873
p	.774	.838	.393	.045*
%	61.32	41.93	19.65	2.27
95% CI	27.87 – 88.94	13.24 – 74.75	1.64 – 54.36	0.00 – 18.99
Z_{cc}	0.34	-0.24	-1.05	-3.15
95% CI	-0.59 – 1.22	-1.12 – 0.67	-2.13 – 0.11	-5.41 - -0.88

Note. * p<.05. μ = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

Table 15.

Patient TC's Temporal-Spatial Domain Scores Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
TC Score	18	31	13	20
Control μ	23.8	32.6	19.6	29.8
Control *SD*	1.92	1.52	5.27	2.39
t	-2.76	-0.961	-1.143	-3.743
p	.051*	.391	.317	.020*
%	2.55	19.55	15.84	1.00
95% CI	0.00 – 20.44	1.62 – 54.25	0.76 – 49.77	0.00 – 10.45
Z_{cc}	-3.02	-1.05	-1.25	-4.10
95% CI	-5.20 - -0.826	-2.14 – 0.11	-2.43 - -0.01	-6.96 - -1.26

Note. * p<.05. *μ* = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

Table 16.

Patient TC's Sensory-Emotion Domain Scores Compared with the Control Group

	Past		Future	
	Unprompted	Prompted	Unprompted	Prompted
TC Score	21	28	16	20
Control μ	24.4	31	21.8	29.4
Control *SD*	4.72	5.05	6.53	5.59
t	-0.658	-0.542	-0.811	-1.535
p	.546	.616	.463	.200
%	27.34	30.82	23.15	9.98
95% CI	4.57 – 62.25	6.33 – 65.44	2.79 – 58.13	0.11 – 40.96
Z_{cc}	-0.72	-0.59	-0.89	-1.682
95% CI	-1.69 – 0.31	-1.53 – 0.40	-1.91 – 0.21	-3.07 - -0.23

Note. μ = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size.

2.3.3.1.2.3 Autonoetic and Clarity Ratings[29]

The analysis of TC's mean autonoetic and clarity ratings is compared with the mean ratings from the control group in Table 17. Her mean autonoetic and clarity ratings did not differ from the controls in the past condition. In future condition, there was a trend for her autonoetic rating to be lower than the controls, but this did not reach significance. Her clarity ratings did significantly differ from the controls until Bonferroni corrections were applied. These results suggests that whilst TC had no difficulty visualising and re-living her simulated past events, the clarity of her future events was reduced.

[29] As TC did not provide any description or rating following the presentation of the cue words lamp and kite in the future condition, the corresponding control data was removed for this analysis.

Table 17

Patient TC's Autonoetic and Clarity Ratings Compared with the Control Group

	Past		Future	
	Autonoetic Rating	Clarity Rating	Autonoetic Rating	Clarity Rating
TC μ	33	41.5	10	10
Control μ	50.2	53.8	31.4	33
SD	8.40	8.01	7.57	6.52
t	-1.869	-1.402	-2.581	-3.220
p	.135	.234	.061	.032*
%	6.75	11.68	3.06	1.61
95% CI	0.01 – 34.34	0.22 – 43.83	0.00 – 22.80	0.00 – 15.12
Z_{cc}	-2.05	-1.54	-2.83	-3.53
95% CI	-3.64 - -0.40	-2.85 - -0.16	-4.89 - -0.75	-6.02 - -1.03

Note. * $p<.05$. μ = mean. *SD* = standard deviation. *t* = Crawford statistic. *p* = probability. % = estimated % of norm population falling below individual score. CI = confidence interval. Z_{cc} = effect size

2.4 Discussion

2.4.1 Study Aims

In line with previous studies, it was hypothesised that patients with focal hippocampal lesions and complaints of poor autobiographical memory would provide less detail in their unprompted descriptions for both past and future events when compared with neurotypical controls. Specifically, it was anticipated that the patients would provide less temporal, spatial, sensory and emotional detail than the controls. Previous research has suggested that patients with this type of hippocampal pathology struggle with MTT because of the crucial role the hippocampus has on generating coherent scene representations of an event (e.g. Hassabis et al., 2007). This study aimed to investigate whether the provision of scaffolding, through verbal prompts, would lessen the executive

demands of the MTT task by guiding the search and retrieval approach for autobiographical memories. It was hypothesised that this would enable the patients to generate past and future events despite their hippocampal damage. It was also hypothesised that if deficits with MTT are predominantly due to a loss of the internal representation of scenes and the cohesion of multimodal sensory detail, then prompting would have no impact on the patients' responses.

2.4.2 Overall Findings

It was hypothesised that all participants (both patients and neurotypical controls) would provide less detail in their unprompted future events than their unprompted past events. This study has generated further evidence supporting the research literature that past MTT is easier than future MTT as all participants were able to provide more detail in their unprompted descriptions than their future descriptions.

It was also hypothesised that the patients would provide less detailed unprompted descriptions for both past and future events compared to the control group. This study's results present a mixed picture; in the case of BG it was only her past unprompted descriptions that were less detailed, whereas TC's unprompted scores in either condition did not significantly differ.

A further hypothesis was that the patients would report disproportionately less temporal, spatial, sensory and emotional detail in both their past and future unprompted MTT descriptions when compared to the control group. This study's results partially support the predicted reduction of detail in the temporal-spatial domain, but neither patient had any significant differences with the amount of sensory and emotional detail given in either their past or future descriptions when compared with the control group. Both patients had a reduction in the amount of temporal and spatial information in their unprompted past descriptions, but this deficit was not noted in either of their unprompted future

descriptions. This finding adds some additional evidence to the theory that the hippocampus is involved with integrating information about where and when an episodic memory is taking place, but suggests that there may be different or additional mechanisms involved with EFT.

The final hypothesis addressed the use of scaffolding through the provision of verbal prompts, which aimed to lessen the impact of executive demands on the MTT task for all participants. Whilst the control group's total scores for their unprompted descriptions were significantly less detailed in the future than the past, with prompting this difference disappeared. This suggests that for neurotypical patients, EFT is more challenging than episodic memory recall, but this difficulty can be overcome through appropriate scaffolding. Patient BG's initial deficit with her past descriptions was ameliorated through scaffolding but TC was unable to elaborate on her future descriptions to a comparable level to the controls.

Further consideration of each patient's performance is discussed in turn below. It is acknowledged that the application of Bonferroni corrections resulted in very conservative probability thresholds from which to determine statistically significant differences. It is unclear as to whether the Singlims.ES and RSDT programs did require such adjustment and there appears to be a case for arguing against Bonferroni applications.[30]

2.4.3 Patient BG

Patient BG's overall scores indicate that she has some difficulties engaging in unprompted MTT. Following the presentation of the words 'lamp' and 'cork' she described events that were typical of her daily routine and arguably involved more semantic than episodic memory recollection. Her marked reduction in her ability to recall

[30] Crawford et al. (2010) present an example of a single case study where four tasks are reported in relation to control data without correction for multiple comparisons.

functional, temporal and spatial details of her episodic memories is consistent with her clinical presentation. Whilst there were no significant differences to the control group in the amount of sensory and emotional detail provided in her past and future descriptions, upon prompting BG reflected that "*I have no emotional contact with any of these words you've given me.*"

Patient BG's difficulties with past MTT do not appear to be due to problems with visualization or abstract thinking. This is evidenced by her VVIQ score, her subjective clarity ratings and scores from her neuropsychology tests. Given how well she was able to utilise prompts to elaborate on both her past and future descriptions, it would seem that her unprompted MTT was hampered by her executive functioning (EF). Whilst there is limited information about her EF skills from the battery of neuropsychological tests that she previously completed (Appendix F), her low scores on the verbal fluency sub-test of the Delis-Kaplan Executive Functioning System (D-KEFS) indicate some difficulty with generating ideas that could be associated with an impaired approach to the search and retrieval of relevant memories.

It may also be that her reduced temporal spatial information is due to lower levels of autonoetic consciousness. Without this crucial subjective sense, individuals are likely to feel very disconnected from their visualisation. On one occasion when asked to rate her sense of MTT for a past description she said "*I don't feel I was there….I'm visualising it*".
A further example of her impaired past MTT, exacerbated by a lack of autonoetic consciousness was when she was asked to describe a past event cued by the word 'rude'. She gave a third person narrative of a row between family members that occurred when she was in a coma resulting from her encephalitis. She confirmed that she had very limited

personal recollection of this event[31] and so could not re-live it, but that it was an episode that she had learnt about subsequently.

2.4.4 Patient TC

Patient TC's difficulties with MTT appear to be limited to the future. Whilst she reports subjective impairment in her episodic memory, her unprompted descriptions of past events were within the range of the control group.

Patient TC's impoverished future descriptions suggest that she was not able to gain much benefit from the scaffolding provided under these conditions. This would indicate that her difficulties are more likely to be a result of an impairment with scene construction associated with hippocampal pathology, as opposed to underlying problems with EF. The limited information on her EF gained from scores on the verbal fluency and colour-word sub-tests of the D-KEFS in her neuropsychology profile (Appendix G) would support this hypothesis as they do not identify any substantial difficulties in this cognitive domain.

Patient TC's autonoetic and clarity ratings were noticeably lower in the future condition than the past condition, suggesting that she felt less able to engage with this direction of MTT when compared with the control group. Of significance, was her reduced clarity score. It is possible that her reduced sense of autonoetic consciousness was a catalyst for her EFT impairment, preventing her from drawing upon her senses to generate a clear scene of an event in her mind.

It is also possible that there may be a psychological element to patient TC's difficulties with prompted EFT. Her score of 12/21 on the anxiety-sub scale of the HADS indicates a moderate level of anxiety and it may be that this is affecting her ability to

[31] Patient BG mentioned that during her coma there were times when she was aware of sounds and smells around her.

undertake EFT. Following a prompt in the future condition she said "*I try not to think about what's going to happen in the future because I never ever know*". On another occasion she said *"I deliberately don't think of the future, I live day to day*". Her apparent reluctance to engage with EFT may be due to her increased awareness of how unpredictable life can be following the operation that led to her presenting difficulties. It may also be that TC's resistance to engage in EFT is an adaptation to her longstanding difficulties. Through avoiding EFT, she is preventing herself from experiencing further distress because she does not have to acknowledge that this is a cognitive skill where she struggles.

2.4.5 Factors That May Have Influenced the Patients' Performance

It is important to consider to whether there may be other factors impacting on the patients' overall performance on the MTT task. Given their low scores on the depression sub-scale of the HADS, it is unlikely that their poor performance was due to mood disturbance. The possibility of a slight reduction in motivation cannot be excluded as a non-specific consequence of brain injury. However, their eagerness to participate in this voluntary study and their overall engagement with the task suggests that motivation was not a significant factor influencing the results.

Unlike some previous MTT tasks (e.g. Hassabis et al., 2007; Race et al., 2011), this study did not request the participants to generate MTT descriptions through the provision of a scenario that gave a temporal and situational context (e.g. winning the lottery next year). It is possible that the freedom to discuss any event that came to mind, without the constraints of a timeframe or location may have increased the ease in which the patients were able to engage in the unprompted conditions of the task. Consequently, the patients' scores may be an over-estimation of their MTT abilities.

2.4.6 Methodological Limitations and Suggestions for Improvement

When assessing the reliability of this study's findings, it is essential to have regard to the control group. Firstly, eligibility to participate was determined through self-report, so without ethical approval to access medical records, the health status of the controls was not able to be corroborated. Secondly, as often happens with case series studies, the control group is very small and this has statistical implications. Finally, there is also the potential issue of the comparison samples' mixed gender. As there is some documented evidence for gender differences in MTT tasks, with women performing better on both episodic memory tasks (e.g. Herlitz & Rehman, 2008) and EFT tasks (Wang, Hou, Tang & Wiprovnik, 2011), it would have been preferable for the control group to have consisted of women only, to match the patients.

One of the controls' descriptions for both the past and future events appeared to be noticeably less detailed than the other controls, particularly in the sensory-emotion domain. Whilst his responses during the pre-assessment screening interview did not identify any reason why he would not meet inclusion criteria to participate in the study's comparison group, his overall performance during the MTT task raised concerns about his memory abilities. This highlights another limitation of this study; that the screening procedure may not have been robust enough to have identified people with pre-existing acquired or developmental memory difficulties. Using the Autobiographical Memory Interview (AMI; Kopelman, Wilson & Baddeley, 1989) would have provided a screening measure for personal semantic and episodic autobiographical memory. Whilst the AMI can be lengthy to administer, its inclusion may have provided a co-variate which could be used in analysing the neurotypical comparison group. Administering the logical memory sub-test from the Weschler Memory Scale (WMS; Weschler, 2009) may have also improved the screening procedure by highlighting possible anterograde episodic memory deficits. A similar battery of neuropsychological tests that were administered to the patients could

have also been undertaken by each of the controls. A measure of executive function, e.g. the verbal fluency task from the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan & Kramer, 2001) would have also enhanced the screening procedure.

Whilst the MTT task seemed to be well tolerated by all the participants, there are possible improvements to consider, particularly as the underlying metrics of the task are unknown. It may have been better to have used only concrete nouns for the word cues, as abstract words tend to be more difficult to cognitively process (Hoffman, 2016), although this does not appear to have been the case in this study[32]. Additionally, the abstract cue words 'luck' and 'free' tend to have positive connotations and, therefore, may have provided an implicit prompt for emotion. During an informal discussion with one of the controls after completing the MTT task, it emerged that the reason why she did not provide a description of a future event prompted by the cue word 'rude' was because she felt uncomfortable imagining herself encountering situations that involved rudeness. This highlights how there are individual differences in how word cues can be appraised. Increased piloting may have assisted with selecting more neutral cue words. Furthermore, the use of structured post-task interviews with all participants may have elicited the reasons behind the few occasions when they were unable to give a description for an event. This would have been particularly helpful with the patients and would give some direction for future studies exploring voluntary MTT.

Another aspect of the MTT methodology that warrants further refinement is the scoring. As previously discussed, both patients (but particularly BG) had a tendency to describe past events that lacked specificity and were linked to daily routine, which may have become consolidated over time into semantic memory. In these examples, additional

[32]There were no significant differences in the level of detail given for descriptions prompted by the abstract and concrete words for both the control group and BG. However, TC was unable to describe future events following two of the three concrete words.

temporal and spatial detail were given following prompts, but they seemed to lack conviction (e.g. when asked when one event took place, BG responded "let's say yesterday"). Such responses could have been given an adjusted score to reflect that whilst detail had been provided there is uncertainty about whether it is true measure of episodic content. Alternatively, consideration could have been given to differentiating between external and internal details (semantic and episodic information) when scoring the descriptions, following the example of the standardized protocol developed by Levine, Svoboda, Hay, Wincour & Moscovitch (2002).

An additional possible improvement to the MTT task may have been to have instructed all participants to close their eyes. Vredeveldt, Hitch and Baddeley (2011) reported how shutting eyes not only improves memory recall, but that it reduces cognitive load and enhances visualisation. These are qualities that could assist with EFT. It is also acknowledged that the autonoetic and clarity ratings were only obtained after prompting, which may have influenced these subjective measures. Therefore, requesting these ratings before and after prompting would have allowed for further informative analysis. It would also have been interesting to have asked participants for ratings on how personally salient each event described was to see if further support could be generated for the notion that future MTT tends to be more self-relevant than past MTT (e.g. D'Argembeau & Van der Linden, 2004).

Finally, the design of the past condition for the MTT involves the subjective recall of an event, focusing on the content irrespective of its validity. An alternative to the word cue recall method, which would have enhanced the task's veridicality, would have been to have used independently verifiable past events and compared the quality of their recall. However, sensory and emotional experiences attached to episodic memories are by their nature subjective and, therefore, difficult to verify.

2.4.7 Clinical Implications

This study's MTT task appears to be a sensitive measure of identifying significant retrograde memory difficulties, as well as difficulties with EFT. With further development, it is hoped that it could be incorporated into routine clinical practice.

Patient BG's results suggest that some patients with focal retrograde amnesia may be more capable at recalling episodic memories if given the right scaffolding. This finding challenges the theory that the experiences of retrograde amnesia are a result of memory degradation (Hassabis et al., 2007). Instead, it highlights the possibility that this condition may be underpinned by executive difficulties, which result in a faulty search and retrieval strategy.

This study also presents preliminary findings that suggest that deficits in MTT can be uni-directional: Patient TC's performance on the MTT task identified difficulties with prompted future descriptions in the absence of significant episodic memory deficits. These results suggests that her impairment cannot be attributed to difficulties accessing and retrieving relevant episodic details from which to base her EFT, as previously proposed by Szpunar (2010). If additional isolated EFT cases could be identified, it may lead to them being categorised as a separate syndrome.

Both the patients in this study experienced different difficulties with MTT. Whilst this may be a direct consequence of impaired hippocampi, it is also possible that the generalised effects of brain damage have contributed to their disproportionately poor performances. Shallice (1988) describes how a task can become unduly more challenging for people with a lost resource, a phenomenon known as performance resource artefact.

2.4.7.1 Future Research

In order to understand fully the mechanisms behind MTT, it would be necessary to extend this study to include patients with other discrete brain lesions.[33] If poor performance was solely a consequence of hippocampal lesions, it would be expected that these other patients would describe a similar level of detail to the controls. If, however, these patients also struggled disproportionately, it would suggest that their difficulty is due to generalised loss of resources. A further development to this study could explore the double dissociation method, which would assist with determining whether a specific function is affected by a specific region on the brain (Shallice, 1988). This could be achieved by identifying another task (Task A) that is of comparable difficulty to the MTT task. If different parts of the brain are responsible for these different tasks, then it may be possible to find participants who perform within a normal range of Task A, but struggle with MTT and vice versa. This methodology does not appear to have been used alongside other MTT studies.

There are many other directions future research in MTT could take. One of these could be exploring the psychological consequences of MTT deficits. An inability to recall personal events from the past is likely to be a frustrating experiencing that may fuel depressive cognitions, which can itself exacerbate amnesia (Seel & Kreutzer, 2003). However, not being able to re-live past distress may in fact act as a protective factor against developing depression.

[33] There is emerging evidence to suggest that other cognitive impairments are also associated with poor performance on EFT tasks (Berryhill, Wencil, Branch, Coslett & Olson, 2010).

2.5 Conclusions

This paper presents two preliminary findings that do not appear to have been reported elsewhere. Firstly it presents the case of a patient with disabling retrograde amnesia who with the assistance of prompts is more able to recall episodic memories and imagine future events. Secondly, it discusses the possibility that there may be a dissociation between the two directions of MTT. Specifically, it reports a patient who exhibits impaired EFT in the absence of significant episodic memory deficits. It is anticipated that this study will be continued to allow for further patient recruitment, with the hope of replicating and expanding on these novel findings.

Appendices

Appendix A Checklist for Assessing the Quality of Quantitative Studies

(Kmet et al., 2004)

	Criteria	Yes (2)	Partial (1)	No (0)	N/A
1	Question / objective sufficiently described?				
2	Study design evident and appropriate?				
3	Method of subject/comparison group selection OR source of information/input variables described and appropriate?				
4	Subject (and comparison group, if applicable) characteristics sufficiently described?				
5	If interventional and random allocation was possible, was it described?				
6	If interventional and blinding of investigators was possible, was it reported?				
7	If interventional and blinding of subjects was possible, was it reported?				
8	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement/misclassification bias? Means of assessment reported?				
9	Sample size appropriate?				
10	Analytic methods described/justified and appropriate?				
11	Some estimate of variance is reported for the main results?				
12	Controlled for confounding?				
13	Results reported in sufficient detail?				
14	Conclusions supported by the results?				

Appendix B National Research Ethics Service (NRES) Approval Letter

NHS
Health Research Authority
NRES Committee South Central - Hampshire B
Level 3 Block B
Whitefriars
Lewins Mead
Bristol
BS1 2NT
Tel: 0117 342 1384

09 April 2015

Dr Christopher Kipps
Consultant Neurologist
University Southampton Hospital Southampton NHS Foundation Trust
Wessex Neurological Centre
University Hospitals Southampton NHS Foundation Trust
Tremona Rd, Southampton
SO16 6YD

Dear Dr Kipps

Study title:	**Young Onsent Dementia Assessment Study: A longitudinal observational study of early onset dementia**
REC reference:	**12/SC/0428**
Amendment number:	**SA6**
Amendment date:	**05 March 2015**
IRAS project ID:	**107834**

The above amendment was reviewed by the Sub-Committee in correspondence.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Covering letter on headed paper	SA6	05 March 2015
Notice of Substantial Amendment (non-CTIMP)	SA6	05 March 2015
Other [Substudy debriefing form]	1	27 February 2015
Other [Peer scientific review]		10 February 2015
Participant consent form [Substudy Consent Form]	1	27 February 2015
Participant information sheet (PIS) [Memory Substudy PIS]	1	08 April 2015
Research protocol or project proposal [Substudy Protocol]	1	27 February 2015
Research protocol or project proposal [YoDA]	1.9	27 February 2015

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

NHS
Health Research Authority

R&D approval

All investigators and research collaborators in the NHS should notify the R&D office for the relevant NHS care organisation of this amendment and check whether it affects R&D approval of the research.

Statement of compliance

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

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

12/SC/0428:	**Please quote this number on all correspondence**

Yours sincerely

pp

Dr Andrew Scott
Alternate Vice-Chair

E-mail: nrescommittee.southcentral-hampshireb@nhs.net

Enclosures: *List of names and professions of members who took part in the review*

Copy to: *Sharon Atwill*

NRES Committee South Central - Hampshire B

Attendance at Sub-Committee of the REC meeting by correspondence

Committee Members:

Name	*Profession*	*Present*
Mrs Angela Iveson	Acute Oncology Clinical Nurse Specialist	Yes
Dr Andrew Scott	Course Leader, M.Sc. Clinical Exercise Science	Yes

Also in attendance:

Name	*Position (or reason for attending)*
Miss Libby Watson	REC Manager

A Research Ethics Committee established by the Health Research Authority

Appendix C Participant Information Sheet

Department of Clinical Neuropsychology

[redacted]

PARTICIPANT INFORMATION SHEET

YODA Sub-Study

Investigating the relationship between remembering the past and thinking about the future

Introduction

The aim of this study is to investigate whether there is a relationship between the ability to recall events from the past and being able to imagine experiencing an event in the future. It will also investigate whether asking specific questions about an event assists people to provide more detailed descriptions regardless to whether they are recalling the past or imagining the future.

Why have I been asked to participate?

You have been invited to participate because you have previously agreed to be a participant in the Young Onset Dementia Assessment (YODA) study and you indicated that you would be willing for us to contact you about additional assessments that may be relevant to your condition.

What will I have to do?

If you give your consent to participate in the study, you will be invited to [redacted], or if it is more convenient, a home visit can be arranged. You will be asked to complete two short questionnaires, one assessing your current mood and the other will consider your ability to visualise images. You will also be asked to complete some paper and/or computer based tasks, which assess memory and thinking. Some of these tasks may be similar to ones you have completed as part of your clinical assessment at the hospital. One of the new tasks will involve asking you to describe events that you remembering experiencing in the past and thinking about possible activities you may undertake in the future. This part of the study will be audio recorded.

All of these tasks will take no longer than 2.5 hours to complete, including break times and involvement in the study will usually only require one appointment.

What are the possible advantages and disadvantages of taking part?

Your participation may contribute to knowledge about cognitive disorders, particularly those characterised by memory difficulties, through the development of new assessment procedures.

The main task will ask you to describe events and memories that come to mind when thinking about a common and neutral noun, for example, “chair”. We are not expecting that this will cause you any distress, but there is a possibility that you may feel upset if you happen to recall an unhappy memory or find it is difficult to do the tasks we ask you to do. If this is the case we can arrange for a member of the clinical team to contact you to provide support or as an alternative, we also provide details of a self-referral counselling service "Southampton Counselling" run by the YMCA Fairthorne Group (see contact details below).

You may decline to complete any of the tasks at any point and/or withdraw from the study without providing a reason. This would not affect the medical care you receive nor your legal rights or your participation in the main YODA study. This sub-study has been reviewed by the South Central - Hampshire B Research Ethics Committee.

Do I have to take part?

Participation in this sub-study is voluntary. If you do decide you would like to take part, you will be asked to sign a consent form with the understanding that you may withdraw from the sub-study at any time without providing a reason. This would not affect the medical care you receive, your legal rights or your participation in the main YODA study. Any data collected up to the point of withdrawal of the sub-study would be put forward for analysis.

If you choose **not** to take part in this sub-study, it will have no impact on your medical care, legal rights or your participation in the main YODA study.

Expenses and Payments

We are able to offer up to £25 to compensate you for any travel expenses incurred as a result of participating in the sub-study. If you require a carer to accompany you to hospital, we can offer £15 to assist with their travel expenses.

Further Information

Who is organising the study?

YODA has been organised by Dr Christopher Kipps, a Consultant Neurologist who works for the [redacted] NHS Foundation Trust. It is a study conducted by a network of cognitive clinics across the south of England. This sub-study is organised by members of the YODA network; Professor Rosaleen McCarthy, a Consultant Neuropsychologist and Georgina Knott, a trainee Clinical Psychologist based at [redacted]

Will my participation in this study be kept confidential?

All personal information collected about you during the course of the research will be kept strictly confidential. Your personal data will be stored under a code rather than your name and the audio recording will be deleted after it has been transcribed. This information will be stored on a password-protected computer in a secured office. Anonymised information will be available to researchers who have been granted approval by the YODA research committee to access the data for continuing associated research studies. All senior investigators and their associates within the research network will have access to the anonymised information.

You are able to request access to your own data at any time. It is advised that this data is reviewed alongside a clinician who can explain any terminology and answer any questions you may have.

What will happen to the results of the sub-study?

It is anticipated that the results of this sub-study will be suitable for publication in scientific journals. You will not be identified in any report, presentation or publication. If you would like to receive information on how to obtain any published results, please contact the Research Co-Ordinator (details below).

Who can I talk to if I have a concern?

Any concerns you may have about this sub-study and your participation may be raised directly to the researchers. If you wish to make a formal complaint, you can do this by contacting [redacted] Patient Support Services on [redacted]

In the unlikely event that you experience harm whilst participating in this sub-study due someone's negligence, then you may have grounds to seek compensation against [redacted]NHS Foundation Trust, but you may be required to pay your legal costs.

Contact Details

Chief Investigator	Dr. Christopher Kipps e-mail: [redacted] Telephone: [redacted]
Sub-Study Lead	Professor Rosaleen McCarthy e-mail: [redacted] Telephone: [redacted]
Sub-Study Research Co-Ordinator	Georgina Knott e-mail: [redacted] Work Mobile: [redacted]
YODA Research Co-Ordinator	Lesley MacKinnon e-mail: [redacted] Telephone: [redacted]
Clinical Team Contact Clinical Nurse Specialist (RMN)	[redacted] email: [redacted] Telephone: [redacted] Mobile: [redacted]
[redacted] Counselling Service	e-mail: [redacted] Telephone: [redacted]
[redacted] Ethics Committee	e-mail: [redacted] Telephone: [redacted]
South Central Research Ethics Committee	e-mail: nrescommittee.southcentral-hampshireb@nhs.net Telephone: 0117 3421384

Appendix D Consent Form

Department of Clinical Neuropsychology

[redacted]

Please initial end box to indicate consent	
I confirm that I have read and understood the participant information sheet dated 08/04/2015 for the YODA sub-study titled 'Investigating the nature of memory complaints in dementia'.	
I have had sufficient time to decide whether to participate in the study and the opportunity to consider the information, ask questions and have had these questions answered satisfactorily.	
I understand that part of the study will involve answering questions that will be audio recorded. These audio recordings will be deleted after they have been transcribed.	
I understand that my participation is voluntary and that I am free to withdraw at any time. I do not have to give a reason for withdrawing and neither my medical care or legal rights, nor my participation in the main YODA study will be affected. If I do withdraw from the sub-study for any reason, I understand that data collected up to my withdrawal will be used	
I agree to participate in this YODA sub-study 'Investigating the relationship between remembering the past and thinking about the future'	

Name of Participant	Date	Signature
Name of Person Taking Consent	**Date**	**Signature**

Original consent form to be filed in site file, 1 copy for participant, 1 copy for medical notes

Appendix E Debriefing Form

Department of Clinical Neuropsychology

[redacted]

Investigating the relationship between remembering the past and thinking about the future

Debriefing Statement

Thank you for participating in this sub-study of the Young Onset Dementia Assessment Study.

The aim of this research was to investigate whether people who have difficulty recalling events from their past also find it difficult to imagine themselves experiencing an event in the future. It also investigated whether asking specific questions about an event assists people to provide more detailed descriptions regardless to whether they are recalling the past or imagining the future. Your data will help increase our knowledge of cognitive disorders, particularly those characterised by memory difficulties and will aid in the development of new assessment procedures. Any reported results will not include your name or any identifiable information. You may have a copy of the main research findings once the project is completed.

This study did not involve any deception and was not intended to cause any harm. However, if you have any concerns about your physical or psychological wellbeing, please discuss this with the sub-study researcher co-ordinator, Georgina Knott and/or your GP. Details of a local counselling service are below.

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the South Central Hampshire Ethics Committee or the [redacted] Ethics Committee (details below).

Signature _____ Date _____

Name _____

Contact Details

Chief Investigator	Dr. Christopher Kipps e-mail: [redacted] Telephone: [redacted]
Sub-Study Lead	Professor Rosaleen McCarthy e-mail: [redacted] Telephone: [redacted]
Sub-Study Research Co-Ordinator	Georgina Knott e-mail: [redacted] Work Mobile: [redacted]
YODA Research Co-Ordinator	Lesley MacKinnon e-mail: [redacted] Telephone: [redacted]
Clinical Team Contact Clinical Nurse Specialist (RMN)	[redacted] email: [redacted] Telephone: [redacted] Mobile: [redacted]
[redacted] Counselling Service	e-mail: [redacted] Telephone [redacted]
[redacted] Ethics Committee	e-mail: [redacted] Telephone: [redacted]
South Central Research Ethics Committee	e-mail: nrescommittee.southcentral-hampshireb@nhs.net Telephone: 0117 3421384

Appendix F Patient BG's Neuropsychological Score Sheet

Date : 17/05/2013

Domain	Test	Sub-Test	Raw Score	Test Statistic	Percentile
Estimate of Pre-Morbid Intelligence	NART		42/50 8 errors	Predicted FSIQ = 121	
Verbal Comprehension	WASI	Vocabulary	75/80	68[b]	95
	WAIS-III	Similarities	23/33	11[a]	63
	GNT		21/30		50-75
Working Memory	WAIS-III	Digit Span	16	10[a]	50
Perceptual Organisation	WASI	Block Design	44/71	57[b]	75
	WASI	Matrix Reasoning	27/32	62[b]	88
	BMIPB	Figure Copy	79/80		98
Processing Speed	WAIS-III	Digit Symbol-Coding	74	13[a]	84
Verbal Memory	BMIPB Version 1	Story Immediate Recall	21/60*	N/A	10-25
	BMIPB Version 1	Story Delayed Recall	14/60*	N/A	10-25

	CVLT	Trials 1-5	54	55[b]	
	CVLT	List B	6	0[c]	50
	CVLT	Short-Delay Free Recall	9	-1[c]	16
	CVLT	Short-Delay Cued Recall	10	1.5[c]	7
Non-Verbal Memory	BMIPB	Figure Immediate Recall	41/79	N/A	2-5
	BMIPB	Figure Delayed Recall	31/78	N/A	10-25
	RMT	Faces	47/50	15[a]	95
Executive Function	D-KEFS	Verbal Fluency			
		Letter	36		20-30
		Category	19		25-50
	Brixton	Spatial Anticipation	6 errors	10[a]	100

Note. [a] = scaled score. [b] = *T* Score. Brixton (Burgess & Shallice, 1997). BMIPB = Birt Memory Information Processing Battery (Coughlan, Oddy & Crawford, 2007).). D-KEFS = Delis-Kaplan Executive Functioning System (Delis, Kaplan, & Kramer, 2001). FSIQ = Full Scale Intelligence Quotient. GNT = Graded Naming Test (Warrington & McKenna, 1980). RMT = Recognition Memory Test (Warrington, 1984). WAIS-III = Wechsler Adult Intelligence Scale (3rd Edition) (Wechsler, 1997). WASI = Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999).

Supplementary Information

It is noted that no formal efforts testing was administered and that these results do not include information on the patient's behaviour during the procedure that would assist with interpretation.

Patient BG scored 3/3 when asked for orientating information (day, month and year). She also completed the HADS, scoring 3/21 on the anxiety sub-scale and 2/21 on the depression sub-scale, which are both below clinical threshold.

Appendix G Patient TC's Neuropsychological Score Sheet

Date : 28/03/2014

Domain	Test	Sub-Test	Raw Score	Test Statistic	Percentile
Estimate of Pre-Morbid Intelligence	NART		40/50 (10 errors)	Predicted FSIQ = 113	81
Verbal Comprehension	WAIS-III	Vocabulary	50/66	12[a]	75
	WAIS-III	Similarities	24/33	11[a]	63
	GNT		21/30		50-75
	SCOLP	Speed of Comprehension	84/100		95-99
Working Memory	WAIS-III	Digit Span	14/30	9[a]	37
Perceptual Organisation	WAIS-III	Block Design	49/68	14[a]	91
	WAIS-III	Matrix Reasoning	17/26	12[a]	75
	RCFTRT	Figure Copy	36/36		100
Processing Speed	WAIS-III	Digit Symbol	72/133	12[a]	75
Verbal Memory	RMT	Words	49/50	15[a]	95
	BMIPB Version 1	Story	22/60	N/A	25-50%

		Immediate Recall			
	BMIPB Version 1	Story Delayed Recall	24/60	N/A	50-75%
	CVLT	Trials 1-5	49	53[b]	62
	CVLT	List B	6	0[c]	50
	CVLT	Short-Delay Free Recall	9	0[c]	50
	CVLT	Short-Delay Cued Recall	12	0[c]	50
	CVLT	Long Delay Free Recall	8	-1[c]	16
	CVLT	Long Delay Cued Recall	10	-0.5[c]	31
	CVLT	Total Intrusions	1	-0.5[c]	31
	CVLT	Total Repetitions	6	-0.5[c]	31
	CVLT	False Positives	1	-0.5[c]	31
Non-Verbal Memory	ROCF	Immediate Recall Delayed Recall	14/36 13.5/36	45[b] 43[b]	31 24
	RCFTRT	Recognition	23/24	66[b]	95
	RMT	Faces	47/50	15[a]	95
	Famous Faces	Recognition	11/12	9-10[a]	95

	Doors & People	Doors Test A	11/12	11[a]	67
		Doors Test B	5/12	8[a]	25
		Total	16/24	9[a]	37
	TRMT		27/30	12-15[a]	75-95
Executive Function	D-KEFS	Verbal Fluency			
		Letter	56	16[a]	98
		Category	38		63
		Category Switching	15	11[a] 13[a]	84
	D-KEFS	Color-Word Interference			
		Colour Naming	33''	10[a]	50
		Word Reading	19''		84
		Inhibition	69''	13[a]	50
		Switching	(1 Self Corrected Error) 69" (2 Uncorrected Errors)	10[a] 12[a]	75
	BCET		17/20	-1.72[c]	5

Note. [a] = scaled score. [b] = *T* Score. [c] = *Z* Score. BCET = Biber Cognitive Estimation Test (Bullard et al. 2004). BMIPB = Birt Memory Information Processing Battery (Coughlan, Oddy & Crawford, 2007). CVLT = California Verbal Learning Test (Delis, Kramer, Kaplan & Ober, 1987). D-KEFS = Delis-Kaplan Executive Functioning System (Delis, Kaplan, & Kramer, 2001). ROCF = Rey-Osterrieth

Complex Figure Test (Osterrieth, 1944). FSIQ = Full Scale Intelligence Quotient. GNT = Graded Naming Test (Warrington & McKenna, 1980). MWCST = Modified Wisconsin Card Sorting Task (Nelson, 1976). NART = National Adult Reading Test (Nelson & Willison, 1991). RCFTRT = Rey Complex Figure Test and Recognition Trial (Meyers & Meyers, 1995). RMT = Recognition Memory Test (Warrington, 1984). SCOLP = Speed and Capacity of Language Processing Test. TRMT = Topographical Recognition Memory Test (Warrington, 1996). WAIS-III = Wechsler Adult Intelligence Scale (3rd Edition) (Wechsler, 1997).

Supplementary Information

It is noted that no formal efforts testing was administered and that these results do not include information on the patient's behaviour or mood during the procedure that would assist with interpretation.

Appendix H Invitation Letter

Private and Confidential

Department of Clinical Neuropsychology

[redacted]

Dear [redacted]

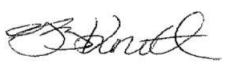
I am writing to you as I am aware that you have previously consented to take part in the YoDA study as a carer to someone who is experiencing cognitive difficulties. You indicated that you would be willing to be contacted by our research team if we were recruiting for other related research studies.

I am conducting a research study looking into memory and future imagination and am looking to recruit healthy participants who do not have memory difficulties to form a comparison group. Participation in the study should take no more than two hours and would involve completing a few questionnaires and tasks. Please find enclosed an information sheet detailing the study.

I can be very flexible with appointment times and would be happy to see you in the daytime, evening or weekend, either at the hospital or if you prefer at your home. Any travel expenses you may incur would be reimbursed.

If you would like to participate in this study or have any questions, please do not hesitate to contact me on the e-mail address or telephone number above. Alternatively, you can send back the attached reply slip in the enclosed stamped addressed envelope indicating your interest in participating and appointment preference.

I look forward to hearing from you.
Best Wishes



Georgina Knott, Trainee Clinical Psychologist
Supervised by Professor Rosaleen McCarthy

Appendix I Participant Registration Form

REC Reference No: 12/SC/0428

YoDA Sub-Study:

Investigating the Relationship between Remembering the Past and Thinking about the Future

REGISTRATION FORM

Title:……

First Name:…….

Surname:…….

Date of Birth:…….

Ethnicity:.……

Address:……

…….

……

……..

…….

Preferred Contact Number:……

E-mail:…….

Sub-Study Participant ID: ……

Appendix J Pre-Assessment Questionnaire

REC Reference No: 12/SC/0428

Sub-Study Participant ID:……..

Pre-Assessment Questions

Highest Level of Education:……

Occupation:……

Current Medications:……

……

……

Past or Current Mental Health Problems (including Depression, Anxiety, Psychosis): **……**

……

……

……

Past or Current Physical Health Problems (e.g. Cancer, Stroke, Chronic Fatigue, Fibromyalgia, IBS)**:**

……

……

……

……

Past or Current Neurological Illness / Head Injuries (including MS, MND, Huntingdon's, Parkinson's, Dementia, Epilepsy, Migraines, Encephalitis, Concussion, Loss of Consciousness)

……

……

Any Past or Current Memory Difficulties:……

……

……

Units of Alcohol Consumed During an Average Week:……..

Number of Caffeinated Drinks Consumed During a Typical Day: ……..

Past and Current Drug Use:
……

……

Overall Health and Wellbeing Today (Rating /10, where 10 is most well) **:**

……

Appendix K National Adult Reading Test (NART)

I want you to read slowly down this list of words starting here [indicate CHORD]. Please wait until I say “next” before reading the next word. I must warn you that there are many words that you probably won’t recognise. In fact most people don’t know them. So just have a guess at these ok? Go ahead.

CHORD	SUPERFLUOUS
ACHE	SIMILE
DEPOT	BANAL
AISLE	QUADRUPED
BOUQUET	CELLIST
PSALM	FACADE
CAPON	ZEALOT
DENY	DRACHM
NAUSEA	AEON
DEBT	PLACEBO
COURTEOUS	ABSTEMIOUS
RAREFY	DETENTE
EQUIVOCAL	IDYLL
NAÏVE	PUERPERAL
CATACOMB	AVER
GAOLED	GAUCHE
THYME	TOPIARY
HEIR	LEVIATHAN
RADIX	BEATIFY
ASSIGNATE	PRELATE
HIATUS	SIDEREAL
SUBTLE	DEMESNE
PROCREATE	SYNCOPE
GIST	LABILE
GOUGE	CAMPANILE

Appendix L Vividness of Visual Imagery Questionnaire (VVIQ)

Instructions

Visual imagery refers to the ability to visualise, that is, the ability to form mental pictures or to "see in the mind's eye." The aim of this test is to determine the vividness of your visual imagery. The items of the test will possibly bring certain images to your mind. You are asked to rate the vividness of each image by reference to the 5-point scale given below. For example, if your image is "vague and dim" then give it a rating of 4. After each item write the appropriate number in the box provided. Please familiarise yourself with the different categories on the rating scale and refer to it when judging the vividness of each image. Try to do each item separately, independently of how you may have done other items.

Scale

1	Perfectly clear and as vivid as normal vision
2	Clear and reasonably vivid
3	Moderately clear and vivid
4	Vague and dim
5	No image at all, you only "know" you are thinking of an object

Items

Think of a friend or relative whom you frequently see (but who is not with you at present) and consider carefully the picture that comes before your mind's eye.

1. The exact contour of their face, head, shoulders, body. ☐
2. Characteristic poses or head, attitudes of body, etc. ☐
3. The precise carriage, length of step etc. in walking. ☐
4. The different colours worn in some familiar clothes. ☐

Visualise the rising sun. Consider carefully the picture that forms before your mind's eye.

5. The sun is rising above the horizon into a hazy sky. ☐
6. The sky clears and surrounds the sun with blueness. ☐
7. Clouds. A storm blows up, with flashes of lightening. ☐

8. A rainbow appears. 

Think of the front of a shop which you often visit. Consider the image before your mind's eye.

9. The overall appearance of the shop from the other side of the road.

10. A window display including colours, shapes and details of the individual items on sale.

11. You are by the entrance. The colour and shape of the door

12. You enter the shop and go to the counter. The counter assistant serves you. Money changes hands. ☐

Finally think of country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye.

13. The contours of the landscape. ☐

14. The colour and shape of the trees. ☐

15. The colour and shape of the lake. ☐

16. A strong wind blows on the trees and on the lake causing waves.

☐

Appendix M Hospital Anxiety and Depression Scale (HADS)

Please read each item and circle the reply which comes closest to how you have been feeling in the past week.

1 I feel tense or wound up:

Most of the time □
A lot of the time □
Occasionally □
Not at all □

2 I still enjoy the things I used to enjoy:

Definitely as much □
Not quite so much □
Only a little □
Not at all □

3 I get a sort of frightened feeling like something awful is about to happen:

Definitely and quite badly □
Yes, but not too badly □
A little, but it doesn't worry me □
Not at all □

4 I can laugh and see the funny side of things:

As much as I always could □
Not quite so much now □
Definitely not so much now □
Not at all □

5 Worrying thoughts go through my mind:

A great deal of the time □
A lot of the time □
From time to time, but not too often □
Only occasionally □

6 I feel cheerful:

Not at all □
Not often □
Sometimes □
Most of the time □

7 I can sit at ease and feel relaxed:

Definitely □
Usually □
Not often □
Not at all □

8 I feel as if I am slowed down:

Nearly all of the time □
Very often □
Sometimes □
Not at all □

9 I get a sort of frightened feeling like "butterflies in the stomach:"

Not at all □
Occasionally □
Quite often □
Very often □

10 I have lost interest in my appearance:

Definitely □
I don't take as much as care as I should □
I may not take quite as much care □
I take just as much care as ever □

11 I feel restless as if I have to be on the move:

Very much indeed □
Quite a lot □
Not very much □
Not at all □

12 I look forward with enjoyment to things:

As much as I ever did □
Rather less than I used to □
Definitely less than I used to □
Hardly at all □

13 I get sudden feelings of panic

Very often indeed □

Quite often □

Not very often □

Not at all □

14 I can enjoy a good book or radio or TV programme:

Often □

Sometimes □

Not often □

Very seldom □

Appendix N Mental Time Travel Task (MTT) Instructions

"I am going to present to you some words, one at a time. These words are cue words, rather like fishing hooks, to use to go fishing in the pool of your memory and imagination. With each word presented, I will ask you to describe an event that comes to mind as a result of that word. For each word, I will let you know whether I would like you to describe an event that you have personally experienced in the past or an event that you can imagine yourself experiencing at some point in the future.

When an event comes to mind, I would like you firstly consider whether you are happy to discuss the event in detail. You can describe any kind of event, it does not matter if it is an important or routine one. Once you have thought of a single, specific event that you are prepared to describe, please take as much time as you need to think about and re-create the event in your mind. I would like you to describe the event in as much detail as possible, ideally for up to two minutes. When describing a past event, please explain it as accurately as possible, without elaboration. When thinking of a future event, please try to imagine experiencing a new event, one that is not solely based on a past event. Whilst you describe your event, I will be taking some notes. When you have finished describing the event, I may ask some extra questions about it. Do you have any questions? Shall we begin?"

Scripted Example for a past event using the cue word "Pond"

"I remember when I was about 9 years old, my grandfather and I were walking our dogs in an open field in the New Forest. I was excited to be able to run around freely with them. Earlier in the day it had been raining heavily, so there were many large puddles and overflowing ponds. Leo & Baz, our Flatcoats, loved to race round off the lead. As they were used to ponds, having one in the garden at my grandparents, they immediately dashed over to a large one to the left on the horizon. As the water was filthy, my grandfather asked me to run after them, to try and stop them from jumping in and getting dirty. However, by the time I reached them, they were already in and having fun! I was trying to coax them out, when I slipped on the muddy edge and ended up joining them in the pond. The water was almost as deep as I was tall. My grandfather heard me scream so ran over, but soon

joined in with my laughter as he saw that I was ok, although a bit shaken. The walk back to the car was another 45 minutes and I remember how horrid it was to be walking in soaking wet clothes in the cold wind. Although it was a sunny spring day, there was quite a chill to the air. With each step, my trainers made a squelching noise!

My grandfather made the dogs & I sit on newspaper to try and protect the car seats. We had all the windows down to try and get rid of the overpowering muddy wet dog smell. When we arrived home, the dogs were washed and I was put in the big yellow bathtub in the upstairs bathroom. My grandmother was furious about the state we were in and feared that I would catch a cold, which I did later that week!"

Appendix O Word Cue List

Condition	Word
Past	Kite
Past	Lamp
Past	Cork
Future	Luck
Future	Rude
Future	Free
Future	Cork
Future	Kite
Future	Lamp
Past	Rude
Past	Luck
Past	Free

Appendix P Recording Sheet

Time questions asked (if under 2 minutes) ……..

PPT No……. **CUE WORD:** **……..**	**Who** **(Objects / People)**	**What**	**Where** **(Location/Building)**	**Why** **(What led to this event)**	**When** **(Season/Year/Age)**	**Sensory** **(Smell, Colour, Sound, Touch, Taste)**	**Emotion**
Future Unprompted							
Future Prompted							

Ppt. No: ……..

Cue Word & Temporal Condition: ……..

On a scale of 0-10, how much did it feel like you had travelled in time to experience the event? (0 not at all, 10 very much) …….

On a scale of 0-10, how clear was the picture of this event in your mind's eye? (0 no picture at all, 10 vivid picture) ……...

Qualitative Observations:

……

……

……

……

……

Appendix Q Excerpts from Patient BG's Transcript

This first excerpt is taken following the presentation of the word lamp, in the

past condition:-

G: So the next word is "lamp"... I'd like you to take your time, to think of a specific event, that comes to mind from your personal past - so something that you... remember experiencing, or think you may have experienced that comes to mind with the word "lamp".

8: There is a lamp next to our bed [Mm-hmm]**... that I have to push the button on quite hard in order for it to come on... and... it's a big Chinese vase, underneath the... light bulb and light shade.**

(10 second pause)

G: So you were saying there's a lamp that's in your bedroom. If you're seeing your bedroom, in your mind's eye, whereabouts is the lamp in relation to you?

008: We have... no, we have them left and right of the bed.

G: OK... and what is the event that you are imaging experiencing that involves these lamps?

8: When I go in the bedroom I turn... the one usually on [redacted] side, so I can see where I'm walking - usually to put a drink down before we go to bed.

G: Mm-hmm... and... forgive me, I was - I didn't quite get some of the description - you were saying a little bit earlier about what the lamp looked like, I think...

8: Yes - a blue and white Chinese bowl-type... at the bottom, and the lampshade on the top of it... and yes, I can see it in my mind's eye.

G: Do you get a sense of when this... memory - I appreciate it's probably a routine event for you **[It is, yes]** - but perhaps the time - a particular, one time that you remember this, when that was, maybe?

008: Last night.

G: Last night, that's fine! And do you know roughly when this was? ... Do you get a sense of the time?

008: Before we went to bed.

G:So ...

008: Probably about eleven o'clock.

G: OK! And... in terms of any sensory information, you've already described to me the colour of the lamp **[Mm-hmm]**... I was just wondering if we think about that... memory of

last night, going to bed - are there any other sounds, or smells, or any other sensory information that's linked to that memory?

008: No... none at all.

G: And are there any emotions that you remember experiencing?

008: No...

G: On a scale of zero to ten, how much did it feel like you'd travelled back in time to re-experience that memory?

008: Say that again slowly?

G: On a scale of zero to ten, how much did if feel like you'd travelled in time - mentally travelled in time - to re-experience that memory? 10 being that you strongly felt it.

008: Travelled? In time?

G: Yes... it's like the ability to almost, sort-of, mentally shift yourself back so it felt like "Yeah I was.. back doing that, re-living it!"

8: Yes, I can visualise it very clearly [OK!]**... what does that mean..? A nine or ten, is it?**

G: OK... so... I'll… I'll put nine to ten in terms of how clear that picture was **[Yes]** in your mind's eye... I think the first question, about that sense of feeling - like did it really feel like you were there or did it feel like you were just sort-of...

008: No, I'm just visualising...

G: Yep, so visualising, but that sense of really feeling like "Ooh yes, that really felt like I was there" **[No, no...]** was that different? On a scale of zero to ten where would you put that?

8: Well I don't feel I was there [At all?]**... I'm not - I'm not there, no, I'm... I am visualising it, but I don't feel connected to it like you were saying, re-living it.**

G: OK... so... it sounds like that for the mental time travel scale, it would be a low number?

008: Yes, I can't say, zero?

This second excerpt is taken following the presentation of the word cork, in the future condition:-

G: Right, we're going to be revisiting some of the words... so this time, we've got the word "cork", and... I would like you think about... a specific event that you can imagine experiencing in the future, that comes to mind, when you hear the word "cork".

008: OK, champagne cork.

G: OK, so we've got the champagne cork... so what specific future event is coming to mind? Take your time to build up the scene in your mind

…

008: Specific event [Mm-hmm]**... I could make up a couple?**

G: Perhaps you can tell me about the one that is most detailed in your mind?

….

[OK] **Well [redacted] and [redacted] don't drink so... let's say [redacted] and [redacted] they... they're getting married** [Mm-hmm] **- they're married - they've just got married** [OK] **because that's when you would use... a champagne bottle, isn't it - yes, there you go...**

(10 second pause)

G: OK

008: Is that right?

G: So you've mentioned - [redacted] and [redacted] they've just got married. Whereabouts are you, as you're popping the champagne?

8: Well if they have the reception over at the Edgemore - in the Edgemore Hotel... if [redacted] and [redacted] want us to have it over there...

G: OK. And... if you can imagine doing a panoramic... look-around, what else can you see, as you're... popping the champagne**...**

008: Again, I'm not being funny, but I would be making this up.

G: That would be absolutely fine, because we're thinking about the future... just if you - if you can **[Right, OK...]** - imagine this, do you know, where you are in this scene?

008: One of the rooms over there, that they've laid out for... a reception.

G: Mm-hmm. What does it look like, if you had to describe it to me?

8: OK - tables, with... napkins on, and... glasses, and cutlery... and them having decorated the tables, the way they decorate them - which I can't remember how it is, but I know they do something [Mm-hmm]**... funny.**

G: OK. And do you get a sense of when this event is happening in the future?

008: Absolutely not, no.

G: No? OK... and... you mentioned the champagne cork **[Mm-hmm]**... a cork popping - do you get - do you have anything else, sort of any further details?

008: Well I know a - I know a name of... a champagne? Moet and Chandon?

G: OK... and... any sensory information? Any smells, or colours, or sounds, or tastes that come to mind when you're visualising popping this champagne cork, at [redacted] and [redacted] wedding reception?

……..

008: Umm … no

G: And what about any emotions? Are there any... how - how are you feeling, in this imagined event - do you get any sense of how you're feeling?

008: Not really, no...

G: That's fine. You're doing well. So if you had to rate how much it felt like you had travelled in time to experience that event on a scale of 0-10, what score would you give.

008: Hmmm, not sure. Is it ok if we take a quick break?

G: Yes, of course.

Appendix R Excerpts from Patient TC's Transcript

This first excerpt is taken following the presentation of the word lamp, in the

past condition:-

G: So, the next word is "lamp", and again I'd like you to take your time, to think of an event that comes to mind, from your past, and to really build up that picture in your mind, and to give a... as detailed a description as possible, that's relating to "lamp".

…

6: Some friends up the road were... had just moved in, and they were... getting themselves sorted, having inevitably brought stuff from the old house [Mm-hmm] **which didn't really fit in to... the new house in the right sort of way** [Mmm] **- it looked sort-of... different and... not dated, but... it was the - a different vibe to... how the house was built, and so forth, and they were going to give this lamp away, or put it on eBay or something** [Yep]**... and I immediately clocked it and said "Oh, we'll have it from you - we'll buy it from you", and they didn't want anything for it at all - they said "Oh, you have it - be great!" - and it's what - exactly - what we've been looking for, for the last... year** [Mmm]**, and haven't been able to buy it anywhere, and of course they said "Oh well, we got it years ago..." and all we had to do was go and buy a new lampshade for it, and we've got it in the sitting room!**

G: Oh, lovely! (10

second pause)

So you mentioned it was friends who were up the road - do you know which friends it was?

006: Oh yes - [redacted]...

G: Mm-hmm. And you mentioned that it was a lamp that didn't really go with the decor...

6: No, because - everything in their place was quite modern [Mm-hmm]**, and they wanted stainless steel, and this lamp... was... a, a goldy-brassy colour, and because this house is nineteen-thirties** [Yep]**, I've got all the original brass handles** [Ohh] **on all the doors, which I've... kept, and maintained - I have to polish them every week, sadly** [Laughs] **- but... because of that, stainless steel just doesn't look right in here** [Yes, yes]**, at all, and everywhere we'd gone, what we were looking for was something... to fit in to our surroundings** [Mmm]**, with the goldy colour - and this was - and everywhere we'd been they were only stainless steel... or chrome.**

G: It was meant to be! So you've described... this sort-of goldy, brassy colour - how else could you describe this lamp so I could picture it in my mind?

6: Straight up for... five foot, and then... it has a right-angled hinge on it, so that it comes out, so it can be used as a reading lamp.

G: OK... and... the moment that... you know, they were saying "Oh, this lamp's not working for us, we're going to get rid of it" and you said "Oh! We'll buy it off you, we'll take it!" - whereabouts were you?

006: In their house.

G: In their house... and where specifically in their house were you? Do you remember?

6: No... might have been the sitting room, might have been the kitchen. I think it was probably the kitchen. You know, it's probably the sitting room, because that's where we were talking about the lamp, and that's where the lamp was.

G: OK... and was there a particular reason why you'd popped in to see [redacted] and [redacted]

006: We'd been invited for dinner.

G: And whenabout was this - this event?

006: About a year ago I suppose.

G: And do you get a sense of what season, what time of year it was?

6: No... those are the sort of things I'd say "Geoff, do you remember?" and he'd say "Oh yes, it was so-and-so..."

G: And you talked already about the colour of the lamp - I was wondering if there was any other sensory information that comes to mind with that memory, so any smells, or sounds, or touch or taste, or anything associated?

6: No, only... I remember the lamp - the original lampshade - was a pretty ghastly colour, and I thought the sooner I get that off the better [Laughs] **- and don't ask me what the colour was** [OK!]**, I can't remember... and I went out and bought a beige-y, white-y one... I think it was a dark - quite a dark colour - they had, which didn't give out much light.**

G: And any emotions that come to mind with that event, that you associate..?

6: No - we were, we were very... very impressed that they gave it to us and didn't want anything for it, really - very grateful.

G: Great. On a scale of zero to ten, how much did it feel like you'd travelled in time to experience that event?

006: Mmm, I don't know... Doctor Who isn't my middle name!

G: [Laughs] And that's fine - some people go "Oh yes, I absolutely felt like I was sort-of re-living it all!"

6: No... no, the only sort... the things... that I relive, are things like... the negatives rather than the positives, funnily enough...

G: Mmm, lots of people say that. So it sounds like it's going to be quite a low number - that sense of time travel **[Yes]**. What number would you say?

006: 4-5

G**:** And how about how clear the picture was, in your mind's eye?

6: Well, as soon as you said lamp [Yep] **- the picture of that lamp** [Yep] **and what I've got in my sitting-room now** [Yep] **- you know, it came up immediately.**

G: Excellent - and so the clarity that...what number would give it on a scale of 0-10 where 10 is most vivid?

006: 10

This second excerpt is taken following the presentation of the word cork, in the future condition:-

G: So... we're going to revisit the word "cork" - we've talked about a time in the past, this time again I'd like you to think about an event you could imagine experiencing in the future that is triggered by the word cork.

6: Right, it's a place I would like to go to, I know diddly-squat about it, but I've never been to Ireland [OK]**. I can't envisage anything, apart from the fact that I know it rains a lot.**

(10 second pause)

G: So in your - in your - image, it's raining?

6: Yes, and it's probably very green, because it's raining [Mm-hmm]**... and everybody's Irish, but I just would like to know a little more about Ireland really.**

(5 second pause)

G: And any sense of who's with you on this imagined trip to Cork?

006: Probably [redacted]... but chances are we'll never get there.

G: OK, so the idea is to build up an event that you could imagine experiencing in the future. Are you doing anything in particular in Cork?

6: I haven't thought about it, because I really don't know - I have done no homework on it whatsoever [OK!] **- and so I don't know what's there to explore** [Mm-hmm]**. I don't even know whether it's inland, or on the sea, on the coast. I have absolutely... no idea about it at all** [OK!] **- it's just that it's a place in Ireland, and I've never been to Ireland.**

G: And any sense of when this imagined trip is taking place?

006: Hmm... twelfth of never, I expect.

G: So... it's kind-of one of these things where you feel like it would be nice but... the imagined event doesn't feel that real to you...

006: Yeah.

G: OK. Any other sensory information or emotions that come to mind?

6: Yes, it's a sense of curiosity, but if [redacted] said to me "Let's go to Cork, for a holiday", I would have to... do a hell of a lot of homework before I agreed to going [Yep]**. Even though I've got that idea in my head that I want to - now, sadly, I tend to want to revisit places that I know I'm going to.**

G: Yep. OK...

6: Because he would like to see the world... and I'm... thinking... I don't need to - I can see it on the box, I can... see all the different indigenous species if I go to London... being the capital of the world now, not England... and... and I think... do I want to - I - I've become increasingly - you know I was born and bred in London, and I left when I was eighteen, and I've never, ever wanted to go back... because I love the coast, I love... the country, and... I love home.

G: So that sense of exploration - unless it somewhere that perhaps is really meaningful to you **[That's right]** - it's sort of, it's less interesting. You would do it for [redacted] but less, less of a pull to you. **[Yeah]** OK - one last question about this. When - if we're imagining this event, [redacted]'s said "Hey, let's go to go to Cork"- do you know where you are when you hear this? That sense of where you may be, if you're visualising, imagining... this event...

006: Could be anywhere... either here or on the boat.

G: OK. So on a scale of zero to ten, how much did it feel like you'd travelled in time, to experience that event?

006: Not really.

G: No? So quite a low number?

006: Yep.

G: What would you say?

006: Two.

G: Yeah? And, on a scale of zero to ten, how clear is the picture, in your mind's eye?

006: Zero.

G: Zero. That's fine.

Appendix S Supplementary Information on Mental Time Travel (MTT) Task

Piloting

The MTT task instructions were developed following pilot work with two participants known to the experimenter. The entire task was administered under experimental conditions using the planned protocol. Consequently, the instructions of the MTT task were modified to improve clarity. After trialling eight cue words, the task was reduced to six to shorten participation time to optimise participant's engagement and minimise fatigue. [34]

Content Analysis of the Participants' Descriptions

When analysing the descriptions from all participants (both patients and the control group), it emerged that similar types of events were described in past and future conditions. There were no significant differences between the type of events described by the patients and controls. There was a trend for the participants' future events to be associated with more positive experiences and emotions than their past events. This is an observation noted in other research papers (Bertnsen & Bohn, 2010; Bertnsen & Jacobson, 2008; D'Argembeau & Van der Linden, 2006, Finnbogadottir & Berntsen, 2013). These future descriptions were often related to anticipated milestone events that were relevant to the participants' late middle age; for example, the birth of grandchildren.

[34] The words 'sour' and 'book' were removed following participant feedback that they found these cue words more difficult to engage with.

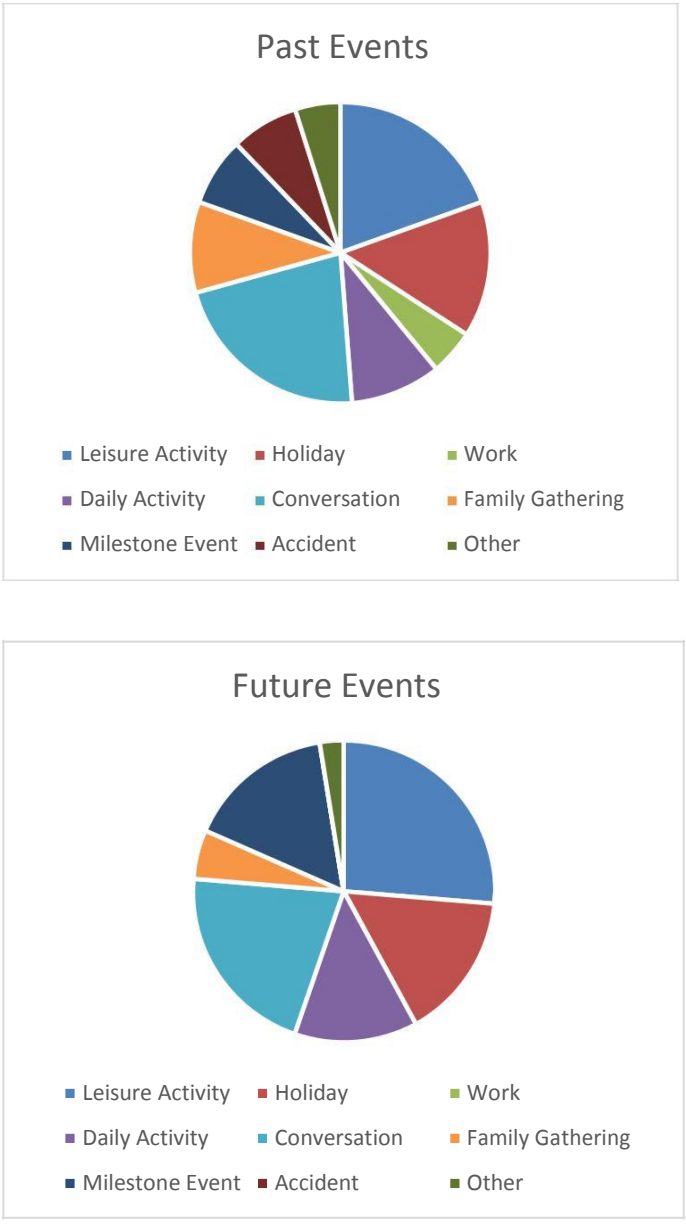


Figure 13. Pie Chart Displaying the Type of Past and Future Events Described by All Participants

It was also observed that the future events that were given a temporal context, tended to be located in the near future, ranging from next month to five years. This contrasted with past events described, some of which took place up to 50 years ago. When sensory detail was provided, it was predominantly visual.

Appendix T Control Group Data

The control group's mean predicted IQ score, was within the average range at 108.2 (*SD* = 6.34, range = 101-114). Their scores on the APM ranged from 5 to 12 (*M* = 9, *SD* = 3.32). Their mean score on the anxiety sub-scale of the HADS was 3.6 out of 21 (*SD* = 4.98, range 0-12). Their mean score on the depression sub-scale of the HADS was 1.2 out of 21 (*SD* = 1.10, range = 0-3). Both of these means were within the non-clinical range. Their VVIQ scores ranged from 22 to 36 out of 80 (*M* =29, *SD* = 5.15). These scores were well matched with the normative data reported by Kihlstrom, Glisky, Peterson, Harvey & Rose (1991) (*M* =33.31, *SD* = 11.76).

Table 18.

Individual Control's Demographic and Questionnaire Data

Gender	Age	Education	NART	NART	APM		HADS		Wellbeing	VVIQ
		Years	Error Score	Predicted IQ	Scaled Score	Percentiles	A	D		
M	43	17	9	114	>15	>95	2	0	8	31
F	61	14	9	114	10	50	12	1	8	27
F	56	13	22	101	11	50-75	4	1	9	22
M	69	13	21	102	15	95	0	3	9	29
M	59	17	13	110	>15	>95	0	1	8	36

Table 19.

Each Control's Total Scores for Each Cue Word

Word	Task	1	2	3	4	5
Cork	PU	16	15	20	13	17
	PP	19	20	21	17	18
	FU	15	15	15	8	18
	FP	21	21	19	16	18
Lamp	PU	17	12	19	15	18
	PP	20	19	21	18	19
	FU	14	12	15	9	16
	FP	21	18	19	18	19
Kite	PU	19	17	17	18	17
	PP	21	21	20	21	20
	FU	17	18	16	8	16
	FP	20	21	20	14	21
Luck	PU	14	20	12	14	17
	PP	21	21	18	17	21
	FU	13	13	9	9	10
	FP	18	21	17	16	19
Rude	PU	16	16	15	11	14
	PP	20	20	20	16	19
	FU	14	11	7	13	9
	FP	19	19	7	d	18
Free	PU	17	13	16	11	18
	PP	20	18	19	15	21
	FU	16	14	8	9	13
	FP	20	20	14	17	18

Note. PU = Past Unprompted. PP = Past Prompted. FU = Future Unprompted. FP = Future Prompted

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