Maxwell James Benjamin B.Sc. (Hons)., M.Sc.

Autobiographical Memory in Alzheimer's Disease

Section A: Autobiographical memory in Alzheimer's disease: A review of assessment methods and the evidence base.

Word count: 5498

Section B: The role of working memory and verbal fluency in autobiographical memory in early Alzheimer's disease and matched controls

Word count: 7976

Section C: Critical Appraisal

Word count: 1931

Overall word count: 15405

A thesis submitted in partial fulfilment of the requirements of Canterbury Christ Church University for the degree of Doctor of Clinical Psychology

September 2013

SALOMONS

CANTERBURY CHRIST CHURCH UNIVERSITY

Acknowledgements

Firstly, I would like to extend my gratitude to all the participants who took part in this study, many of whom had also made other research commitments. It was a real privilege to be able to share in their memories. I would also like to thank the clinicians who facilitated recruitment at the various sites for their time and effort.

Thanks also go to my supervisors Dr. Diana Caine and Dr. Fergal Jones for their time and patience. Their guidance from the project's inception to completion was invaluable. I must also thank those peers who provided advice, support and encouragement over these three years.

Last, but by no means least, I would like to thank (and apologise to!) my friends and family for tolerating my absences, and Marie, for without her unwavering support and belief, this task would have seemed impossible.

Summary of the Portfolio

This thesis examines Autobiographical memory (AM) in Alzheimer's disease (AD). Specifically**, Section A** reviews the literature pertaining to the assessment of AM in AD in the context of test reliability, validity, and AM and long-term memory (LTM) theory. The review suggests that theoretical understanding of how AMs are retrieved in AD, and how LTM in general is consolidated over time, has been limited by the methodological shortcomings of some measures which have not received the necessary scrutiny.

Section B investigates the relationship between AM and the working memory (WM) and executive functions predicted to facilitate AM search and retrieval. It employs between-groups and correlational components with participants with early-stage AD and healthy controls matched for age, education, and intellectual ability. It uses an arguably more valid AM assessment task than has been used previously with AD samples in order to capture all aspects of semantic and episodic AM search and retrieval. The results indicate that weaker verbal fluency, but not WM, mediates a decline in episodic AM retrieval in AD independent of typical ageing effects. The clinical implications are discussed.

Section C provides a critical appraisal of the research process by answering four specific questions.

Table of Contents

List of Tables

Section A: Literature Review

Section B: Empirical Paper

List of Figures

Section A: Literature Review

Section B: Empirical Paper

Section D: List of Appendices

Maxwell James Benjamin B.Sc. (Hons)., M.Sc.

Major Research Project

Section A: Literature Review

Autobiographical memory in Alzheimer's disease: A review of assessment methods and the evidence base.

Word count: 5498

September 2013

SALOMONS

CANTERBURY CHRIST CHURCH UNIVERSITY

Abstract

Autobiographical memories (AMs) are constructed representations of personal experience incorporating semantic knowledge and episodic details in a framework of self-relevant goals and beliefs important for wellbeing. Consequently, the loss of this ability in Alzheimer's disease (AD) can have devastating consequences for an individual's sense of self. AM is not routinely, formally assessed when a diagnosis of AD is in question, and methodological considerations for its assessment have not received as much scrutiny as relatively more discrete cognitive functions. Following a systematic search of the literature, the review established that semi-structured, cue-word, and verbal fluency based tasks have been used to assess AM in AD; however the reliability and validity with which they assessed the truly episodic aspects of AM varied considerably. The tasks also varied in their associations with the working memory and executive functions predicted to facilitate AM retrieval by current AM theory. Furthermore, despite insights from studies measuring AM retrieval from different life-periods in AD samples, the nature of long-term memory consolidation remains a highly contentious topic, most likely due to the methodological variability with which AM has been measured. The review concludes with the implications for clinical assessment, interventions, and directions for future research.

1. Introduction

1.1. Autobiographical Memory

Autobiographical memories (AMs) are past, personal recollections of facts and events. Empirical studies of AM have generally been based on Tulving's delineation of long-term memory (LTM) into two main components: semantic information (facts, knowledge); and episodic events (recollection of the "how", "what", "where" and "when", accompanied by an experience of reliving) (Tulving, 1972, 1985, 2002). AM moves beyond general LTM for facts and events in that it integrates individual perspective and interpretation, and "sense of self" over time (Conway, 1990; Fivush, 2011). AMs are important for the "enduring experience as an individual" (Conway & Pleydell-Pearce, 2000, p. 261), and as such do not represent a literal recall of the past; instead they are constructed representations of personal experiences incorporating sensory and perceptual details at the expense of factual accuracy (Conway, 1990).

This Constructive Model of AM (Conway & Pleydell-Pearce, 2000) states that episodic AM can be accessed via *generative* and *direct* retrieval. Generative retrieval, illustrated in Figure 1, refers to a cue (e.g. the question "did you enjoy your time at university?") initiating a hierarchical search, facilitated by executive control processes and working memory (WM), in which "lifetime events" in semantic memory are identified (e.g. "studying at university"), which cues the search and retrieval of more specific semantic knowledge (general events; e.g. "the months writing my thesis") until finally, event-specific knowledge (ESK) is activated and the phenomenological details (i.e. sensory, perceptual, temporal, spatial and affective content) are retrieved, bound-together (reconstructed) and recollected (attended to) in the mind's eye (e.g. "my horror at spilling a drink on computer"). Recollection of ESK has been described as *autonoetic consciousness*, or *autonoesis* (Tulving, 1985). Direct retrieval refers to the instantaneous access to ESK and subsequent

recollection without a hierarchical search of lifetime periods or general events. Flashbacks in post-traumatic stress disorder are an extreme example of this phenomenon, where a cue (e.g. a loud noise) triggers the immediate episodic reliving of a past event.

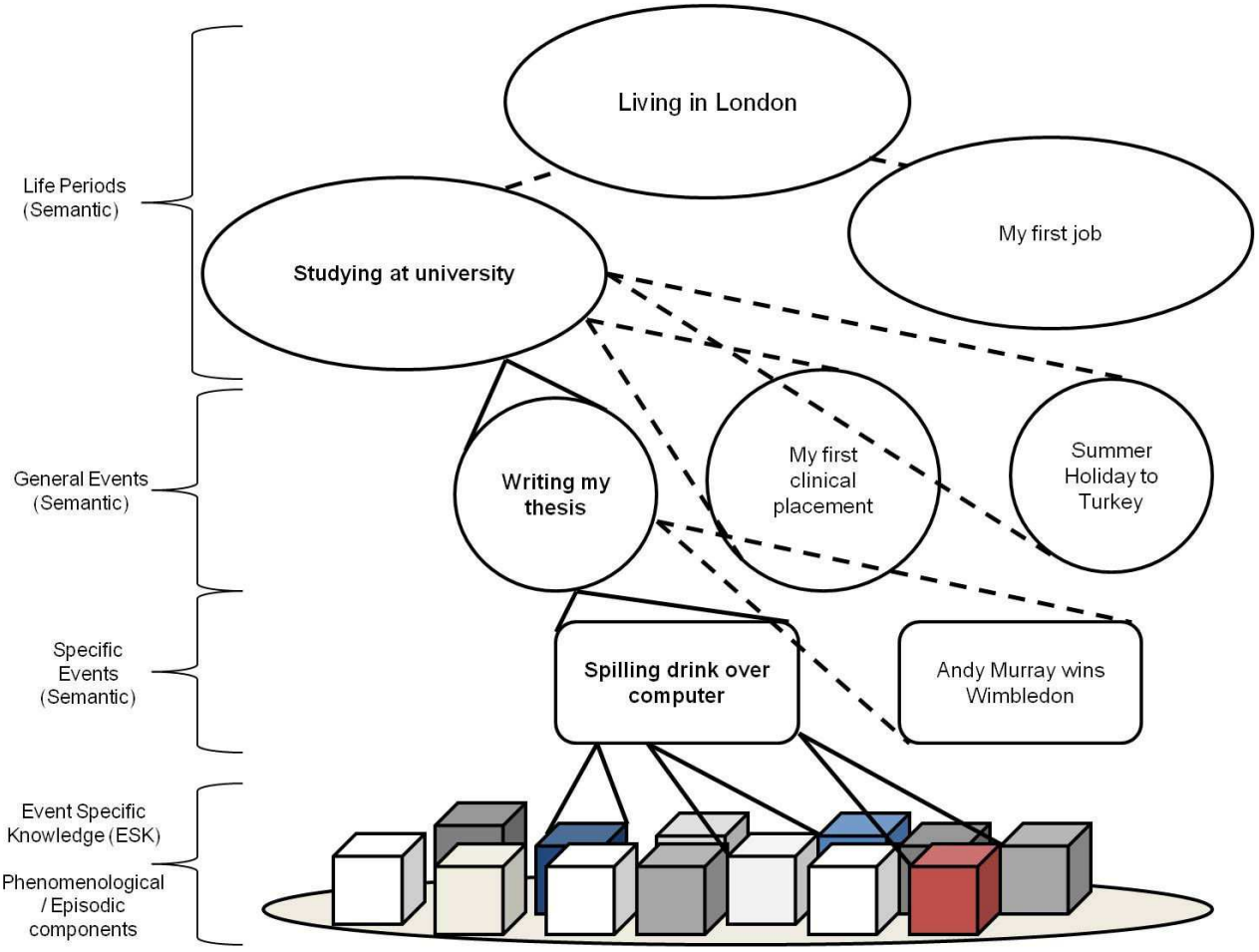


Figure 1. Hierarchical search in generative retrieval of autobiographical memories according to Conway and Pleydell-Pearce (2000).

The model describes AM as a dynamic cognitive and affective process between episodic memory and self-relevant goals and beliefs, referred to as the *working self* (Conway, Singer, & Tagini, 2004), and the process of encoding phenomenological details serves to update ESK and the long-term self-concept (Conway et al., 2004). AM is, in essence, a

mechanism for making sense of experiences, developing core beliefs and assumptions about the Self, and developing ways of relating to others, with the ultimate aim of achieving a stable self-concept (Howe, 2011). It is no surprise then, that loss of this cognitive function might be predicted to have devastating consequences for individuals and their families (Conway & Fthenaki, 2000; Howe, 2011).

1.2. Alzheimer's Disease

Perhaps the most salient example of the loss of past, personal memories is Alzheimer's disease (AD). AD is a progressive, neurodegenerative disease characterised initially by anterograde memory difficulties, misplacing common items, word-finding difficulties, forgetting to perform routine tasks, or disorientation in unfamiliar surroundings (Clare, Woods, Moniz Cook, Orrell, & Spector, 2003), due to the medial temporal lobe (MTL) atrophy that typically occurs in the early stages of the disease (Fox et al., 1996).

1.3. AM and Long-Term Memory in AD

The quantity and quality of AMs that people are able to consciously recall differs throughout the lifespan (e.g. none during the period of so-called "infantile amnesia", and most during the "reminiscence bump" around middle age) (Conway, 1990; Howe, 2011). Furthermore, two prominent competing theories of how LTM is consolidated predict different temporal patterns of AM recall in the presence of the MTL pathology in early AD. Examining the pattern of AM retrieval from across the lifespan in AD is important because AM is dependent on LTM access, and the presence or absence of a temporal gradient in the

context of pathology in the memory network in the brain promises to throw light on the nature of LTM consolidation which remains highly contentious.

Thus, the *standard model* states that the retrieval of recent memories requires MTL structures (in particular, the hippocampi) to bind together this recent information activated in neocortical structures; but that over time they become independent of the MTL and encoded into "semanticised" LTM traces in the lateral temporal lobes (Alvarez & Squire, 1994; Cermak, 1984; Squire & Alvarez, 1995). The standard model predicts that initial AD pathology will result in a pattern of retrograde amnesia that conforms to Ribot's law (Nestor, Graham, Bozeat, Simons, & Hodges, 2002): with more distant memories better preserved than more recent memories (Ribot, 1881), henceforth referred to simply as a *temporal gradient*.

In contrast, the Multiple Trace Theory (MTT; Nadel & Moscovitch, 1997) states that, unlike semantic knowledge, episodic details are encoded throughout the MTL and thus the hippocampi are required for their retrieval for as long as the memory traces exists. The MTT deviates from the standard model in that it predicts the loss of episodic memory across all life-periods with MTL atrophy, and so there should be no temporal gradient for episodic AM in AD (Nestor et al., 2002).

1.4. AM Assessment Considerations

AM is not routinely, formally assessed when a diagnosis of AD is in question, largely because it is not usually necessary to assist with differential diagnosis. However, it is perhaps for this reason that the methodological considerations for its assessment have not received as much scrutiny in the literature compared with relatively more discrete cognitive domains such as object naming. Methodological rigour in the testing of AM in AD is

important not only to inform theoretical understanding of LTM but also for the reliable measurement of a person's ability to remember aspects of the Self in dementia before and after psychosocial or pharmacological intervention, in order to develop a stronger evidence-base for these interventions.

1.4.1. Reliability and Validity

The main indicators of methodological rigour are test reliability and validity. Classical Test Theory (Spearman, 1907) states that all responses to psychological tests are subject to measurement error. The score obtained is the sum of the "true" score (i.e. a theoretically perfect score), and random error (De Champlain, 2010). Tests of AM are also subject to measurement error, as it is highly unlikely that any one test, administered once, will capture all possible "correct" responses, or be perfectly replicable. The *reliability* of a test, then, provides an estimate of the concordance between theoretically "true" scores and the observed score on any one occasion (De Champlain, 2010); it is an estimate of a test's replicability, precision, and internal consistency. Test *validity* is an indication that it does indeed measure the intended construct (Clark-Carter, 2010). Forms of reliability and validity relevant to AM tasks are defined in Appendix A, and referred to in the literature review below.

1.5. Aims of The Review

The purpose of this paper is therefore to systematically review the existing empirical literature concerned with the assessment of AM in AD. Specifically, it serves to answer the following questions:

i) What measures have been used to assess AM in AD and how reliable/valid are they?

ii) Are the tasks consistent with AM and LTM theory?

iii) What are the clinical implications for AM assessment and intervention?

iv) What are the areas for future research?

2. Method

2.1. Search Methodology

Electronic databases were searched from their earliest entries to January 2013 using keywords relevant to AM and AD (Appendix B). Studies without a healthy control group were excluded because there is a known effect of typical ageing on both semantic and episodic AM (e.g. Piolino et al., 2010), and so it would not be possible to know how results from assessment of AM in AD reflected the dementia pathology versus typical ageing.

2.2. Identification of Assessment Measures

Measures of AM used in the included studies were recorded and their original references sought for additional description, reliability and validity data. As this review concerns AD, discussion of reliability and validity will be restricted to AD samples and original test developer report, and findings from other neurological conditions are only reported where relevant to the discussion of AM in AD.

3. Literature Review

3.1. Measures of AM in AD

AM measures can be broadly categorised as semi-structured interviews, cue-word tasks, fluency tasks, or combined measures. The validity and reliability of these measures are outlined below and summarised in Table 1. The content validity column serves as a commentary on how well the measure in question assesses AM in the context AM and LTM theory, based on this literature review. Thus the following judgements of content validity are made: *poor* (the measure does not represent current understanding of how AM is constructed) (Conway & Pleydell-Pearce, 2000); *satisfactory* (the measure captures the main aspects of the AM process but with some methodological limitations); and *good* (the measure captures all aspects of the AM process, as far as possible given current understanding). See Appendix C for a list of the identified studies, their respective AM measures and sample information.

3.1.1. Semi-structured interviews

In general, these tasks consist of asking interviewees to provide information about personal facts and events across the lifespan, usually divided into five life-periods. The responses are typically scored according to predefined criteria for semantic and episodic detail, with the exception of the Family Line Test (FLT; Kazui et al., 2000) and the Autobiographical Memory Scale (AMS; Dorrego et al., 1999), which only measure semantic AM and therefore do not allow for the measurement of generative retrieval.

The degree to which the other semi-structured interviews measure episodic details varies from more general ratings of "richness" (Autobiographical Memory Enquiry [AME]; Borrini, Dall'Ora, Sala, Martinelli, & Spinnler, 1989), measures of semantic and episodic AM

(Autobiographical Memory Interview [AMI], Kopelman, Wilson, & Baddeley, 1989; Autobiographical Interview [AI], Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002) to two recently developed, very specific measurements of autonoesis: The *Test Episodique de Mémoire du Passé autobiographique* (TEMPau; Piolino, Belliard, Desgranges, Perron, & Eustache, 2003); and the Episodic Autobiographical Memory Interview (EAMI; Irish, Lawlor, O'Mara, & Coen, 2008) both allow for the quantification of the remembering experience (Griffith, Kleim, Sumner, & Ehlers, 2012).

Inter-rater reliability coefficients for semi-structured tasks were all satisfactory, ranging from .7 for the AME through to .9 for the EAMI. Test-retest reliability data were available for the FLT and the AMS, both of which were satisfactory. Concurrent validity data were only available for the AMI and this varied by study and participant group. For example, concurrent validity coefficients ranged from .27 to .76 for healthy controls, and .59 to .69 for AD samples (Kopelman et al., 1989). The TEMPau task demonstrated convergent validity coefficients between .45 to .62 for combined AD and healthy control samples. It was possible to derive divergent validity coefficients for the AMI (good), AMS (good), and FLT (poor) from the studies identified by the literature search. The AMI was judged to fall short of good content validity as it does not assess autonoesis.

3.1.2. Cue-word tasks

The earliest measure of AM identified was the Crovitz technique (Crovitz & Schiffman, 1974; Galton, 1879), a cue-word task. Interviewees are prompted for AMs by associating with cue words read from a list (e.g. "box", "visit", "hurt"). Responses are scored according to their "richness". Similarly, the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986) uses emotional cue words described by Robinson (1976). Interviewees

are typically given one minute to recall and date a specific personal memory in response to each word (and are prompted if they are unable to do so). Responses are scored as either general (longer than a day or undated) or specific memories (less than a day).

Inter-rater reliability coefficients were better for the AMT than the Crovitz test, however test-retest reliability for the Crovitz test demonstrated that it is extremely stable over time. Both convergent and divergent validity of the AMT appeared to be better for AD groups than healthy control groups. Whilst the cue-word tasks should facilitate direct retrieval, the scoring schedules for these tasks do not adequately distinguish episodic from semantic AM and thus content validity for both scales was rated as poor.

3.1.3. Fluency tasks

The Autobiographical Fluency task (ABF; Dritschel, Williams, Baddeley, & Nimmo-Smith, 1992) was the only verbal fluency task identified. Interviewees are asked to recall as many autobiographical episodes or personal facts as possible within a specified time limit over several life-periods, and a point is awarded for each accurate response. The task does not require details of a particular episodic event, only for the person to briefly describe the type of event (e.g. "visiting so and so") before moving on. It is therefore questionable as to whether this method assesses truly episodic memories, and it was therefore judged to fall short of good content validity, although the scoring criteria could potentially be adapted. Divergent validity for the ABF task in an AD sample was poor, although concurrent validity was good (these discrepancies may reflect the semantically-weighted scoring used in this study).

Table 1.

Reliability and validity coefficients for autobiographical memory (AM) tasks in healthy control (HC) and Alzheimer disease (AD) samples identified by the search strategy.

	Reliability Coefficients			Validity Coefficients						
	Test-retest		Inter-rater	Concurrent		Convergent		Divergent		Content Validity Rating
Measure	HC	AD		HC	AD	HC	AD	HC	AD	
Crovitz	.997	.92	.74							Poor
AMT			.87-.96			-.01	.82	.42	.28	Poor
AME			.70					.23-.26		Poor
AMI			.82-.86	.27-.76	.59-.69			.02-.38		Satisfactory
ABF					.59-.69	-.22	.57	.19	.38-.60	Satisfactory
AMS		.96						-	.03-.39	Poor
FLT	.86								.66	Poor
AI			.88-.96			.65-.68				Good
TEMPau			.82-.86			.45-.62				Good
EAMI			.942							Good

Note. Coefficients are stratified by group where the data were available; Convergent validity refers to similar results with equivalent tests (e.g. the episodic scale of the ABF task with the event scale from the AMI); Divergent validity was inferred from the extent to which a test correlated with a theoretically different construct in a given study (e.g. the episodic scale of the ABF with the semantic scale from the AMI, or tests of ABM with tests of intelligence, etc.), with lower coefficients representing better divergent validity. AMT = Autobiographical Memory Test; ABME = Autobiographical Memory Enquiry; AMI = Autobiographical Memory Interview; ABF = Autobiographical Fluency; AMS = Autobiographical Memory Scale; FLT = Family Line Test; AI = Autobiographical Interview; TEMPau = *Test Episodique de Mémoire du Passé autobiographique*; EAMI = Episodic Autobiographical Memory Interview

3.1.4. Combined measures

Several studies have attempted to combine two measures of AM in order to compensate for an individual test's limitations. For example, Ivanoiu et al. (2006) constructed an Autobiographical Questionnaire (ABQ) consisting of two parts: the first

corresponding to the AMI, and the second corresponding to a free-recall ABF task. This potentially allowed for the elaboration of semantic responses in the free recall condition, thus allowing for more detailed exploration of the episodic AM responses than would the AMI alone.

3.2. Relationships Between AM, Executive Function and WM in AD

In order to determine how well the AM tasks relate to the Constructive Model of AM, the review will now examine the relationships between the various assessment methods and the cognitive functions predicted to facilitate AM recall.

3.2.1. Semi-structured AM tasks

Responses to semi-structured interview questions are likely to begin the hierarchical search procedure at the lifetime-period level (e.g. "tell me about your first day at school" might prompt a search of the life-period "being at primary school"), before further search of semantic knowledge of the school (e.g. the name and location of the school), and subsequent recollection of a particular episode (e.g. arriving at the school gates), which must then be communicated. Semi-structured AM tasks are therefore likely to be associated with executive function and WM as predicted by the Constructive Model.

Performance on the AMS has been predicted by scores on semantic knowledge, comprehension and low-demand executive tasks (Dorrego et al., 1999), but no relationships between the FLT (the other personal semantic task) and other cognitive functions have been reported in AD to date.

Turning to a more robust measure of AM, Greene, Hodges and Baddeley (1995) document strong, significant relationships between performance on the AMI, dual performance tasks (assessing executive control) and semantic AM (*r*s = .54-.56), and moderate, significant relationships between letter fluency and semantic (*r* = .44) and episodic (*r* = .42) AM. In contrast, Ivanoiu, Cooper, Shanks and Venneri (2006) found no association between verbal fluency or digit-span (measuring sustained attention and WM) and semantic or episodic AM using their ABQ (see 3.1.4., above).

Using the AME, Sartori, Snitz, Sorcinelli and Daum (2004) found a significant, strong (r_s = .72) relationship between semantic fluency and the total AM score (indicative of the degree of episodic richness) for the AD group, but not for their healthy control group (r_s = -.02). In contrast to this, Eustache et al. (2004) found that semantic fluency was related to greater AM recall from remote life-periods (which the authors argue was indicative of more semanticised AM) but not recent, episodic AM on an experimental AM task very similar to the TEMPau in design.

In a study of the effects of music evocation on AM recall, El Haj, Fasotti and Allain (2012) reported that performance on executive tests of shifting, updating, and inhibition were more strongly associated with generative retrieval (episodic AM retrieval in a no-music condition; *r*s = .35-.57) compared to direct retrieval (i.e. music-evoked episodic AM; *r*s = .37-.41) on the TEMPau task. This pattern of executive involvement in generative retrieval is also supported by dissociable patterns of results with AD, semantic dementia and frontal-variant frontotemporal dementia samples (Piolino, Desgranges, et al., 2003). Of the two studies that have examined autonoesis in AD (Irish, Lawlor, O'Mara, & Coen, 2011; Piolino, Desgranges, et al., 2003), neither reported specific relationships between executive function or WM measures and AM performance.

3.2.2. Cue-word AM tasks

In contrast to semi-structured measures, cue-word tasks may initially facilitate more direct retrieval via existing trace associations between the cue and ESK. This is consistent with Moscovitch's (1994, 1995) theory of associative and strategic retrieval in which the rapid, automatic activation of a memory trace by a cue is made possible by a strong medial temporal-cortical trace; but in either the absence of a specific cue, or the absence of a strong memory trace associated with presented cues, a strategic (or generative) search is initiated, drawing on executive functions (El Haj et al., 2012).

Moses, Culpin, Lowe and McWilliam (2004) reported significant, strong associations between semantic fluency and greater categorical memories (specific, semantic AM; r = .823), and between backwards digit-span and fewer extended memories (life-period semantic AM; r = -.728) in their AD group but not for controls. There were no relationships between a phonemic fluency task and measures of AM for either group. Importantly the effects of processing speed appeared not to influence these relationships when it was controlled for. The authors suggested that these relationships reflected a difficulty within the AD group of inhibiting categorical memories and over-generating extended memories, which would be consistent with the Constructive Model's prediction of poor generative elaboration when executive and WM functions are compromised. However, the lack of relationships between these variables in the control group suggests that the AMT may be subject to ceiling effects and may not be capturing the full spectrum of AM retrieval. This could be because the authors did not include negative cues at the request of their ethics committee. As direct retrieval is more likely to occur when the episode is emotionally salient, opportunities for this may have been missed (albeit for sound ethical reasons), and so the results of this study must be interpreted with caution. The only other study to use the AMT in an AD sample (Donix et al., 2010) did not report relationships between AM,

executive functions or WM. Neither study that used the Crovitz task (Nestor et al., 2002, Experiment 2b; Sagar, Cohen, Sullivan, Corkin, & Growdon, 1988) reported data on these relationships.

3.2.3. Fluency-based AM tasks

Results from the ABF task support a significant, strong relationship between semantic fluency and semantic and episodic AM in AD (*r*s = .57 and .60, respectively) (Sartori et al., 2004) , and letter fluency and semantic and episodic AM in AD (*r*s = .42-.49, respectively; Greene et al., 1995). The relationship between ABF and dual task performance was mixed, with one task significantly, moderately correlating with both semantic and episodic AM (*r*s = .36 and .40, respectively), while another only significantly, moderately correlating with semantic AM (*r* = .36) (Greene et al., 1995). Given that the ABF task is a fluency task it is likely to be more dependent on executive functions than untimed or semi-structured tasks. With limited cueing, the ABF task will require effective hierarchical search and retrieval and the relationships reported between fluency tasks and both semantic and episodic AM support this.

3.2.4. Summary

The inconsistencies of the documented relationship between AM, executive functions and WM may reflect how far the different measures tap the different levels of AM recall. For instance, it is quite possible that the AMI episodic score is not a measure of truly episodic AM but rather a measure of specific semantic knowledge, primarily represented in the semantic knowledge-base, not ESK. Similarly, the ABF task does not require elaboration of

episodes and as such might be considered a fairly poor indicator of episodic AM, which may account for the unclear relationship between WM measures and the ABF task. On the other hand, the EAMI task differentiates recall for specific episodes (measured on the episodic scale) from autonoesis (measured on the autonoetic scale), and results with AD and healthy older adult samples suggest that different cognitive processes are required for these different levels of AM access in order that the cognitive effort of autonoesis be avoided when retrieving most episodic events unless a specific "reliving" process is initiated (Irish, Lawlor, et al., 2011).

3.3. Patterns of AM Recall Across the Lifespan in AD

To determine how well the AM tasks relate to theories of LTM consolidation, the review will now examine the empirical literature reporting AM recall from different life-periods (i.e. temporal gradients) in people with AD.

Of cued-recall studies, only those using the Crovitz test reported data on temporal gradients. Sagar et al. (1988) assessed AM on two separate days in order to compare un-cued and cued AM recall. Episodic AMs that could be recalled on both occasions were analysed by age-of-episode, and a temporal gradient was found. Nestor et al. (2002, Experiment 2b) assessed participants with AD, semantic dementia, and frontal variant frontotemporal dementia, and also only analysed episodic AM by age-of-episode. By calculating a remote-recent index, the authors demonstrated a temporal gradient in AD however it was not significantly different from their control group, making it difficult to draw conclusions about LTM consolidation.

Patterns of recall with semi-structured measures were mixed. The overall AM temporal gradient found with the AME did not differ significantly between the groups

(Sartori et al., 2004). Although a greater score on the AME indicates greater episodic richness, semantic and episodic AM were not scored as discrete categories so they were not compared between-groups. It was therefore not clear whether the overall AM gradient accounted for one, or both of these aspects of AM.

Even studies that used the same measure have varied considerably with respect to patterns of semantic and episodic AM recall. Of those that used the AMI, three studies have found temporal gradients in the pattern of episodic, but not semantic AM (Barnabe, Whitehead, Pilon, Arsenault-Lapierre, & Chertkow, 2012; Graham & Hodges, 1997; Greene et al., 1995); two studies have found temporal gradients in the pattern of semantic, but not episodic AM (consistent with MTT) (Addis & Tippett, 2004; Ivanoiu, Cooper, Shanks, & Venneri, 2004); three studies did not find a temporal gradient for either semantic or episodic AM (Hou, Miller, & Kramer, 2005; Meeter, Eijsackers, & Mulder, 2006; Nestor et al., 2002, Experiment 2a); two studies have found temporal gradients for both episodic and semantic AM (consistent with the standard model) (Irish et al., 2006; Leyhe, Müller, Milian, Eschweiler, & Saur, 2009); and two studies did not report data on temporal gradients (Greene & Hodges, 1996; Greene, Miles, & Hodges, 1996).

Patterns of recall using the AI were similarly inconclusive. Neither of the two studies that reported temporal gradient data found gradients for semantic nor episodic AM in the AD group compared to controls (Barnabe et al., 2012; Irish, Hornberger, et al., 2011). However, Irish, Hornberger et al. (2011) suggested that a temporal gradient might be present for episodic AM when the AD group was compared to participants with semantic dementia in a detailed probe condition only. Barnabe et al. (2012) also suggest a possible temporal gradient for episodic AM, but that this may be the product of a rehearsal effect. Whilst it is difficult to draw conclusions from only two studies, they might suggest that people with AD have the ability to recall episodic details with detailed prompts, but that

fluent retrieval is somewhat compromised. This is not only consistent with the role of executive function in AM retrieval as per the Constructive Model, but also evidence for the MTT; however a temporal gradient would need to be established more clearly in future studies using the AI.

A temporal gradient has not been established for measures of autonoetic consciousness (Irish, Lawlor, et al., 2011; Piolino, Desgranges, et al., 2003).

In summary, the pattern of AM retrieval from across the lifespan remains a highly contentious topic.

3.4. Further Methodological Issues

Most studies of AM in AD have matched healthy control participants by age and education, with some exceptions (Dorrego et al., 1999; Ivanoiu et al., 2006; Nestor et al., 2002). Ivanoiu et al. (2004) did not report age-matching data. Two studies explicitly reported group-matching by reading ability in addition to age and education (Greene & Hodges, 1996; Greene et al., 1996).

Studies of AM in AD have varied considerably in terms of their sample sizes, from just n = 6 (Graham & Hodges, 1997; Nestor et al., 2002, Experiment 2b) to n = 33 (Greene & Hodges, 1996) in the AD group. Control groups have generally been of equal or near-equal size to their respective AD groups, if not larger.

The identified studies can tentatively be categorised by sample severity. For example, two studies used relatively severe AD samples with MMSE means of 11.8 (Sartori et al., 2004) and 19.85 (Addis & Tippett, 2004), whilst most other studies used more mildly affected samples with MMSE means of between 20.3 (Leyhe et al., 2009) and 26.2 (Greene et al., 1995),

which is likely to have some relationship to differential patterns of AM recall. For example, Nestor et al. (2002) commented on the "striking" observation of poor performance by their AD group overall, which might call into question the representative nature of their sample.

4. Discussion

A discussion now follows, organised with reference to the initial aims of the review.

4.1. What Measures have been used to assess AM in AD and how reliable / valid are they?

The literature review above has identified the different methods used to assess AM in AD. The sparse documentation of reliability and validity data in the existing literature (see Table 1, p. 22) supports the notion that due consideration has not been given to the methodological rigour of AM assessment in AD compared with other tests of cognitive function. Perhaps the most important aspect of reliability for AM measures is inter-rater reliability (which can be taken as a proxy indication of the clarity and quality of the scoring system), and this has generally been established across all categories of tasks in AD with the exception of the ABF task.

The generally high inter-rater reliability coefficients suggest that the disagreements about the existence of variable relationships and temporal gradients are not due to unreliable scoring schedules. Given the significant methodological differences of existing tests, concurrent and convergent validity may be less indicative of quality presently. This review included studies that assessed AD samples as well as healthy controls, and so it is reasonable that the reported reliability and validity statistics are generalisable, particularly as it is the prose that is scored, rather than responses specific to a given condition.

4.2. Are the AM Tasks Consistent with AM and LTM Theory?

Based on the available literature, a tempting interpretation of the relationships between generative processes and AM is that the episodic buffer brings the constructed, or bound features of WM into conscious awareness facilitating the mental reliving of an event; whilst executive control processes are differentially responsible for hierarchical search, inhibition of irrelevant information, and updating of the working self in response to new experiences and reconstructed previous experiences.

Cermak (1984) is generally credited in the literature as being the first to suggest that the semantic-episodic distinction is a continuum, rather than categorical. This idea parallels the concepts of noesis (drawing on semantic memory) and autonoesis in AM (Vandekerckhove & Panksepp, 2009). Existing measures of AM are clearly variable in the extent to which they assess this continuum (i.e. their content validity) in AD. Most historical methods of AM assessment do not allow for scoring of truly episodic reliving even if they do elicit it. Consequently, reporting of results for "episodic AM" may not be valid. Furthermore, studies have differed considerably in their findings with respect to temporal gradients for both semantic and episodic AM in AD, which presents problems for both models of LTM consolidation and our understanding of how truly episodic AMs are relived, and indeed lost. As a result, the choice of test in AM assessment must take these factors into consideration.

4.3. What are the Clinical Implications for AM Assessment and Intervention?

It is unclear whether the measurement of autonoesis provides additional, useful information to clinical assessment, given the length of time it takes to assess this accurately (Irish, Lawlor, et al., 2011). This will largely depend on the association between autonoesis, noesis, and wellbeing, or sense of self. The identification of more frequent remembering as a

main predictor of autonoesis in the Irish et al. (2011) study appears to suggest that regular rehearsal of episodic AMs may preserve the relived experience, contrary to the standard model's predictions that this would become lost in the semantisation process. Similarly, findings from the AI might suggest that additional cueing can help elicit episodic details in the presence of retrieval difficulties. These are possible explanations for improved AM in studies of life-review therapy (Serrano, Latorre, Gatz, & Montanes, 2004), and improvements to mood and cognitive function in reminiscence therapy (Cotelli, Manenti, & Zanetti, 2012; Woods, Spector, Jones, Orrell, & Davies, 2005). In terms of therapeutic work in AD, it is not currently clear what level of AM is important or necessary to activate (e.g. specific semantic or truly episodic) to improve or maintain wellbeing. It may be that semantic knowledge of the Self is enough.

A further difficulty is the phenomenon of confabulation in AD (Kern, Van Gorp, Cummings, Brown, & Osato, 1992) and how this might mask "true" AM effects. Some studies have tried to control for this by asking an informant to verify participant AMs, however it seems this is only a valid method for semantic AMs as, by its very definition, autonoesis it is a personal perspective. Arguably, confabulation becomes even less important as AM, according to the Constructive Model (Conway & Pleydell-Pearce, 2000), might be considered to involve varying degrees of confabulation in the sense that it is not necessarily factually correct. Indeed, confabulated accounts may still serve to support the sense of self (e.g. Bortolotti & Cox, 2009).

This review suggests that it may be useful to use a time-limited verbal fluency task across life-periods, using a well validated scoring schedule (such as the AI) when there is a difficult differential diagnosis between AD and other dementia types, as it might be more sensitive to subtle temporal gradients in comparison to relatively short semi-structured interviews. Piolino et al. (2010) developed such a task for the assessment of AM, although to date it is yet to be tested with AD samples.

4.4. Directions for Future Research

The effects of current methods of cognitive rehabilitation/training in AD appear to be unclear (Bahar-Fuchs, Clare, & Woods, 2013). The intricate link between AM and the Self suggests that AM-focussed interventions might be a useful direction for rehabilitation interventions to follow in people with AD. However, the relationships between executive and WM functions and AM retrieval are complex and need further investigation in order to implement appropriate cueing procedures and measures in intervention studies in the future. Several questions remain to be answered by further research:

1) What is the role of verbal and visual working memory in truly episodic AM reliving?
2) What are the predictors of autonoesis during AM recall in AD and can these be incorporated into clinical assessment?
3) To what degree is wellbeing or sense of self in AD associated with noetic or autonoetic consciousness in AM recall?
4) Is AM cueing an effective psychosocial intervention in AD?

References

Addis, D. R., & Tippett, L. J. (2004). Memory of myself: Autobiographical memory and identity in Alzheimer's disease. *Memory*, *12*(1), 56–74. doi:10.1080/09658210244000423

Alvarez, P., & Squire, L. R. (1994). Memory consolidation and the medial temporal lobe: A simple network model. *Proceedings of the National Academy of Sciences of the United States of America*, *91*, 7041–7045.

Bahar-Fuchs, A., Clare, L., & Woods, B. (2013). Cognitive training and cognitive rehabilitation for mild to moderate Alzheimer's disease and vascular dementia. *Cochrane Database of Systematic Reviews*, *6*, CD003260. doi:10.1002/14651858.CD003260.pub2

Barnabe, A., Whitehead, V., Pilon, R., Arsenault-Lapierre, G., & Chertkow, H. (2012). Autobiographical memory in mild cognitive impairment and Alzheimer's disease: A comparison between the Levine and Kopelman interview methodologies. *Hippocampus*, *22*(9), 1809–25. doi:10.1002/hipo.22015

Borrini, G., Dall'Ora, P., Sala, S. Della, Marinelli, L., & Spinnler, H. (1989). Autobiographical memory. Sensitivity to age and education of a standardized enquiry. *Psychological Medicine*, *19*(01), 215. doi:10.1017/S0033291700011181

Bortolotti, L., & Cox, R. E. (2009). "Faultless" ignorance: Strengths and limitations of epistemic definitions of confabulation. *Consciousness and Cognition*, *18*(4), 952–65. doi:10.1016/j.concog.2009.08.011

Cermak, L. S. (1984). The episodic semantic distinction in amnesia. In: L. R. Squire & N. Butters (Eds.), *The Neuropsychology of Memory* (pp. 52–62). New York: Guilford Press.

Clare, L., Woods, R. T., Moniz Cook, E. D., Orrell, M., & Spector, A. (2003). Cognitive rehabilitation and cognitive training for early-stage Alzheimer's disease and vascular dementia. *Cochrane Database of Systematic Reviews*, (4), CD003260. doi:10.1002/14651858.CD003260

Clark-Carter, D. (2010). *Quantitative Psychological Research* (3rd Ed.). Hove, East Sussex: Psychology Press.

Conway, M. A. (1990). *Autobiographical Memory*. Buckingham: Open University Press.

Conway, M. A., & Fthenaki, A. (2000). Disruption and loss of autobiographical memory. In: L. S. Cermak (Ed.), *Handbook of Neuropsychology: Memory and its Disorders* (2nd ed., pp. 281–312). Amsterdam: Elsevier.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, *107*(2), 261–288. doi:10.1037//0033-295X.

Conway, M. A., Singer, J. A., & Tagini, A. (2004). The self and autobiographical memory: Correspondence and coherence. *Social Cognition*, *22*(5), 491–529. doi:10.1521/soco.22.5.491.50768

Cotelli, M., Manenti, R., & Zanetti, O. (2012). Reminiscence therapy in dementia: A review. *Maturitas*, *72*(3), 203–5. doi:10.1016/j.maturitas.2012.04.008

Crovitz, H. F., & Schiffman, H. (1974). Frequency of episodic memories as a function of their age. *Bulletin of the Psychonomics Society*, *4*, 517–518.

De Champlain, A. F. (2010). A primer on classical test theory and item response theory for assessments in medical education. *Medical Education*, *44*(1), 109–117. doi:10.1111/j.1365-2923.2009.03425.x

Donix, M., Brons, C., Jurjanz, L., Poettrich, K., Winiecki, P., & Holthoff, V. A. (2010). Overgenerality of autobiographical memory in people with amnestic mild cognitive impairment and early Alzheimer's disease. *Archives of Clinical Neuropsychology*, *25*(1), 22–7. doi:10.1093/arclin/acp098

Dorrego, M. F., Sabe, L., García Cuerva, A., Kuzis, G., Tiberti, C., Boller, F., & Starkstein, S. E. (1999). Remote memory in Alzheimer's disease. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *11*(4), 490–7.

Dritschel, B. H., Williams, J. M. G., Baddeley, A. D., & Nimmo-Smith, I. (1992). Autobiographical fluency: A method for the study of personal memory. *Memory & Cognition*, *20*(2), 133–140. doi:10.3758/BF03197162

El Haj, M., Fasotti, L., & Allain, P. (2012). The involuntary nature of music-evoked autobiographical memories in Alzheimer's disease. *Consciousness and Cognition*, *21*(1), 238–46. doi:10.1016/j.concog.2011.12.005

Eustache, F., Piolino, P., Giffard, B., Viader, F., De La Sayette, V., Baron, J.-C., & Desgranges, B. (2004). "In the course of time": A PET study of the cerebral substrates of autobiographical amnesia in Alzheimer's disease. *Brain*, *127*(7), 1549–60. doi:10.1093/brain/awh166

Fivush, R. (2011). The development of autobiographical memory. *Annual Review of Psychology*, *62*(c), 559–82. doi:10.1146/annurev.psych.121208.131702

Fox, N. C., Warrington, E. K., Freeborough, P. A., Hartikainen, P., Kennedy, A. M., Stevens, J. M., & Rossor, M. N. (1996). Presymptomatic hippocampal atrophy in Alzheimer's disease. A longitudinal MRI study. *Brain, 119*(6), 2001-2007.

Galton, F. (1879). Psychometric experiments. *Brain*, *2*(2), 149–162. doi:10.1093/brain/2.2.149

Graham, K. S., & Hodges, J. R. (1997). Differentiating the roles of the hippocampus complex and the neocortex in long-term memory storage: Evidence from the study of semantic dementia and Alzheimer's disease. *Neuropsychology*, *11*(1), 77–89. doi:10.1037/0894-4105.11.1.77

Greene, J. D. W., & Hodges, J. R. (1996). The fractionation of remote memory. *Brain*, *119*(1), 129–142. doi:10.1093/brain/119.1.129

Greene, J. D. W., Hodges, J. R., & Baddeley, A. D. (1995). Autobiographical memory and executive function in early dementia of Alzheimer type. *Neuropsychologia*, *33*(12), 1647–1670. doi:10.1016/0028-3932(95)00046-1

Greene, J. D. W., Miles, K., & Hodges, J. R. (1996). Neuropsychology of memory and SPECT in the diagnosis and staging of dementia of Alzheimer type. *Journal of Neurology*, *243*(2), 175–90.

Griffith, J. W., Kleim, B., Sumner, J. A., & Ehlers, A. (2012). The factor structure of the Autobiographical Memory Test in recent trauma survivors. *Psychological Assessment*, *24*(3), 640–6. doi:10.1037/a0026510

Hou, C. E., Miller, B. L., & Kramer, J. H. (2005). Patterns of autobiographical memory loss in dementia. *International Journal of Geriatric Psychiatry*, *20*(9), 809–15. doi:10.1002/gps.1361

Howe, M. L. (2011). *The Nature of Early Memory*. New York: Oxford University Press.

Irish, M., Cunningham, C. J., Walsh, J. B., Coakley, D., Lawlor, B. A., Robertson, I. H., & Coen, R. F. (2006). Investigating the enhancing effect of music on autobiographical memory in mild Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, *22*(1), 108–20. doi:10.1159/000093487

Irish, M., Hornberger, M., Lah, S., Miller, L., Pengas, G., Nestor, P. J., Hodges, J. R., et al. (2011). Profiles of recent autobiographical memory retrieval in semantic dementia, behavioural-variant frontotemporal dementia, and Alzheimer's disease. *Neuropsychologia*, *49*(9), 2694–702. doi:10.1016/j.neuropsychologia.2011.05.017

Irish, M., Lawlor, B. A., O'Mara, S. M., & Coen, R. F. (2008). Assessment of behavioural markers of autonoetic consciousness during episodic autobiographical memory retrieval: A preliminary analysis. *Behavioural Neurology*, *19*(1-2), 3–6.

Irish, M., Lawlor, B. A., O'Mara, S. M., & Coen, R. F. (2011). Impaired capacity for autonoetic reliving during autobiographical event recall in mild Alzheimer's disease. *Cortex*, *47*(2), 236–49. doi:10.1016/j.cortex.2010.01.002

Ivanoiu, A., Cooper, J. M., Shanks, M. F., & Venneri, A. (2004). Retrieval of episodic and semantic autobiographical memories in early Alzheimer's disease and semantic dementia. *Cortex*, *40*(1), 173–175. doi:10.1016/S0010-9452(08)70939-0

Ivanoiu, A., Cooper, J. M., Shanks, M. F., & Venneri, A. (2006). Patterns of impairment in autobiographical memory in the degenerative dementias constrain models of memory. *Neuropsychologia*, *44*(10), 1936–55. doi:10.1016/j.neuropsychologia.2006.01.030

Kazui, H., Hashimoto, M., Hirono, N., Imamura, T., Tanimukai, S., Hanihara, T., Ikeda, M., et al. (2000). A study of remote memory impairment in Alzheimer's disease by using the Family Line Test. *Dementia and Geriatric Cognitive Disorders*, *11*(1), 53–58. doi:10.1159/000017214

Kern, R. S., Van Gorp, W. G., Cummings, J. L., Brown, W. S., & Osato, S. S. (1992). Confabulation in Alzheimer's disease. *Brain and Cognition*, *19*(2), 172–82.

Kopelman, M. D., Wilson, B. A., & Baddeley, A. D. (1989). The autobiographical memory interview: A new assessment of autobiographical and personal semantic memory in amnesic patients. *Journal of Clinical and Experimental Neuropsychology*, *11*(5), 724–744. doi:10.1080/01688638908400928

Levine, B., Svoboda, E., Hay, J., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging, 17*(4), 677-689.

Leyhe, T., Müller, S., Milian, M., Eschweiler, G. W., & Saur, R. (2009). Impairment of episodic and semantic autobiographical memory in patients with mild cognitive impairment and early Alzheimer's disease. *Neuropsychologia*, *47*(12), 2464–9. doi:10.1016/j.neuropsychologia.2009.04.018

Meeter, M., Eijsackers, E. V, & Mulder, J. L. (2006). Retrograde amnesia for autobiographical memories and public events in mild and moderate Alzheimer's disease. *Journal of Clinical and Experimental Neuropsychology*, *28*(6), 914–27. doi:10.1080/13803390591001043

Moscovitch, M. (1994). Memory and working memory: Evaluation of a component process model and comparisons with other models. In: D. L. Schacter & E. Tulving (Eds.), *Memory Systems* (pp. 269–309). Cambridge, MA: MIT Press.

Moscovitch, M. (1995). Recovered consciousness: A hypothesis concerning modularity and episodic memory. *Journal of Clinical and Experimental Neuropsychology*, *17*, 276–290.

Moses, A., Culpin, V., Lowe, C., & McWilliam, C. (2004). Overgenerality of autobiographical memory in Alzheimer's disease. *The British Journal of Clinical Psychology*, *43*(4), 377–86. doi:10.1348/0144665042388964

Nadel, L., & Moscovitch, M. (1997). Memory consolidation, retrograde amnesia and the hippocampal complex. *Current Opinion in Neurobiology*, *7*(2), 217–27.

Nestor, P. J., Graham, K. S., Bozeat, S., Simons, J. S., & Hodges, J. R. (2002). Memory consolidation and the hippocampus: Further evidence from studies of autobiographical memory in semantic dementia and frontal variant frontotemporal dementia. *Neuropsychologia*, *40*(6), 633–54.

Piolino, P., Belliard, S., Desgranges, B., Perron, M., & Eustache, F. (2003). Autobiographical memory and autoneotic consciousness in a case of semantic dementia. *Cognitive Neuropsychology*, *20*(7), 619–39. doi:10.1080/02643290242000899

Piolino, P., Coste, C., Martinelli, P., Macé, A.-L., Quinette, P., Guillery-Girard, B., & Belleville, S. (2010). Reduced specificity of autobiographical memory and aging: Do the executive and feature binding functions of working memory have a role? *Neuropsychologia*, *48*(2), 429–40. doi:10.1016/j.neuropsychologia.2009.09.035

Piolino, P., Desgranges, B., Belliard, S., Matuszewski, V., Lalevée, C., De la Sayette, V., & Eustache, F. (2003). Autobiographical memory and autonoetic consciousness: Triple dissociation in neurodegenerative diseases. *Brain*, *126*(10), 2203–19. doi:10.1093/brain/awg222

Ribot, T. (1881). *Les Maladies de la Mémoire*. Paris: Germer-Baillière.

Robinson, J. A. (1976). Sampling autobiographical memory. *Cognitive Psychology*, *8*(4), 578–595. doi:10.1016/0010-0285(76)90020-7

Sagar, H. J., Cohen, N. J., Sullivan, E. V., Corkin, S., & Growdon, J. H. (1988). Remote memory function in Alzheimer's disease and Parkinson's disease. *Brain*, *111*(1), 185–206. doi:10.1093/brain/111.1.185

Sartori, G., Snitz, B. E., Sorcinelli, L., & Daum, I. (2004). Remote memory in advanced Alzheimer's disease. *Archives of Clinical Neuropsychology*, *19*(6), 779–89. doi:10.1016/j.acn.2003.09.007

Serrano, J. P., Latorre, J. M., Gatz, M., & Montanes, J. (2004). Life review therapy using autobiographical retrieval practice for older adults with depressive symptomatology. *Psychology and Aging*, *19*(2), 272–277. doi:10.1037/0882-7974.19.2.272

Spearman, C. (1907). Demonstration of formulae for true measurement of correlation. *American Journal of Psychology*, *18*, 161–169.

Squire, L. R., & Alvarez, P. (1995). Retrograde amnesia and memory consolidation: A neurobiological perspective. *Current Opinion in Neurobiology*, *5*(2), 169–177. doi:10.1016/0959-4388(95)80023-9

Tulving, E. (1972). Episodic and semantic memory. In: E. Tulving & W. Donaldson (Eds.), *Organization of Memory* (pp. 381–403). New York: Academic Press.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology*, *26*, 1–12.

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, *53*, 1–25. doi:10.1146/annurev.psych.53.100901.135114

Vandekerckhove, M., & Panksepp, J. (2009). The flow of anoetic to noetic and autonoetic consciousness: A vision of unknowing (anoetic) and knowing (noetic) consciousness in the remembrance of things past and imagined futures. *Consciousness and Cognition*, *18*(4), 1018–28. doi:10.1016/j.concog.2009.08.002

Williams, J. M., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *Journal of Abnormal Psychology*, *95*(2), 144–149. doi:10.1037/0021-843X.95.2.144

Woods, B., Spector, A., Jones, C., Orrell, M., & Davies, S. (2005). Reminiscence therapy for dementia. *Cochrane Database of Systematic Reviews*, (2), CD001120. doi:10.1002/14651858.CD001120.pub2

Maxwell James Benjamin B.Sc. (Hons)., M.Sc.

Major Research Project

Section B: Empirical Paper

The role of working memory and verbal fluency in autobiographical memory retrieval in early Alzheimer's disease and matched controls

Word count: 7976

For submission to Journal: *Neuropsychologia*

September 2013

SALOMONS

CANTERBURY CHRIST CHURCH UNIVERSITY

Abstract

Aim: Retrieval of autobiographical memories (AMs) is important for "sense of self". Current theoretical understanding of AM retrieval predicts that working memory (WM) and executive functions (ExF) enable the hierarchical search for, and reliving of past, personal events in the mind's eye. However, there remains a lack of consensus as to the nature of the relationships between these cognitive functions and semantic and episodic aspects of AM. The present study therefore aimed to explore the associations between these variables in a sample with a wide range of ability on measures of WM, ExF, and AM.

Design: The study incorporated a between-groups component, and a correlational component with regression and mediation modelling.

Method: Participants with Alzheimer's disease (n = 10) and matched healthy controls (n = 10) were assessed on measures of semantic and episodic AM search and retrieval, auditory and spatial WM, and verbal fluency.

Results: AD group AMs were significantly less episodic in nature compared to controls. There were no significant associations between WM measures and hierarchical search of semantic AM, or episodic AM retrieval. Verbal fluency, but not WM, predicted episodic AM retrieval and mediated the effect of dementia status on episodic AM retrieval independent of age effects.

Conclusions: People with AD may be limited in their retrieval of episodic AM due to weaker verbal fluency, independent of ageing effects. WM appeared to play little role in facilitating episodic AM retrieval. Reminiscence interventions for people with AD might benefit from incorporating structured, individualised external memory-aids to facilitate more effective AM search and retrieval to prolong wellbeing.

1. Introduction

Autobiographical memories (AMs) are important for the enduring experience of self (Conway & Pleydell-Pearce, 2000), and as such do not represent a literal recall of the past, but are reconstructed, hierarchical representations of personal experiences incorporating, at the most specific level, sensory and perceptual details at the expense of factual accuracy (Conway, 1990). AM retrieval is a dynamic cognitive and affective process between episodic memory and self-relevant goals and beliefs (the "working self"; Conway, Singer, & Tagini, 2004). Tulving (1985) termed the accompanying cognitive, affective and perceptual experience during "truly episodic" recall, *autonoetic consciousness*, or *autonoesis*. It has also been described as "mental time-travel" when remembering an event through the mind's eye (Moscovitch, Yaschyshyn, Ziegler, & Nadel, 1999).

The Constructive Model of AM (Conway & Pleydell-Pearce, 2000) proposes two methods of AM retrieval: *generative retrieval*, involving the hierarchical search of personal semantic information (semantic AM) for information relevant to a query in order to facilitate access to event-specific knowledge in episodic memory (episodic AM); and *direct retrieval*, where the semantic search is bypassed due to a strong association between a cue and episodic AM. The model predicts that executive control components of working memory (WM) enable hierarchical search and subsequent "reliving" of AMs to take place, and that when these are disrupted generative retrieval will be inefficient and may not allow for adequate specificity to access episodic AM, resulting in "overgeneral" AM (Sumner, Griffith, & Mineka, 2011), manifested as the disproportionately semantic content of AM reproductions.

Traumatic brain injury, neurodegenerative and other neurological diseases can result in AM impairment particularly when there is damage to the medial temporal structures of the brain which is important for the continued access to episodic memories (Nestor, Graham, Bozeat, Simons, & Hodges, 2002). Difficulty accessing episodic memories, in turn,

has been associated with impairments to various aspects of the sense of self (Fargeau et al., 2010), the individual's sense of who they are.

Perhaps the most prevalent form of medial temporal lobe damage is Alzheimer's disease (AD). AD is a progressive neurodegenerative condition characterised by medial temporal lobe atrophy in the early stages, affecting anterograde memory. Subsequently, the pathology spreads laterally and to anterior and posterior cortical areas, affecting cognitive function more widely (Almkvist, 1996). The loss of AM in AD then, has potentially devastating consequences for the individual and their family (Conway & Fthenaki, 2000; Howe, 2011). This has prompted researchers to develop novel paradigms for the exploration of the cognitive processes involved in AM generation as this could ultimately inform rehabilitation techniques to help maintain an individual's sense of self for as long as possible.

Whilst *direct* retrieval may be the most cognitively efficient method of eliciting AMs, very specific cue material is not always available, known by carers, or even consciously accessible to the individual in rehabilitation or care settings. As a result, the relationships between the proposed cognitive mechanisms enabling *generative* AM retrieval (i.e. executive functions [ExF] and WM) have been explored more extensively in the literature. Before outlining the existing evidence for these relationships, the terms are defined specifically below.

1.1. Working Memory

WM is thought to comprise four functions or processes: the phonological loop, the visuospatial sketchpad, and the episodic buffer, all coordinated by central executive functioning (see 1.2., below) (Baddeley, 2000). The phonological loop allows for the temporary (short-term) storage of auditory information, over no more than a few seconds unless it is subject to articulatory rehearsal. Its capacity is typically assessed with digit-span

tasks such as those in the Wechsler scales (e.g. Wechsler, 1997, 1998). The visuospatial sketchpad is the visual equivalent to the phonological store, typically assessed with spatial-span tasks such as the Corsi block-tapping task (Corsi, 1972) or the Wechsler spatial-span task (Wechsler, 1998). The episodic buffer is the most recent addition to the WM model and is proposed to be responsible for the binding of information or features from multiple sources, though it is assumed to have limited capacity (Baddeley, 2000). However, recent research has suggested that feature-binding might actually occur non-consciously in the phonological and visuospatial stores (Allen, Hitch, Mate, & Baddeley, 2012; Baddeley, Allen, & Hitch, 2011), or in the medial-temporal lobes (Pertzov et al., 2013), prior to representation in the buffer when the information is made available to conscious awareness. Thus, in the context of AM, the episodic buffer may serve as an interface for autonoetic "reliving" of bound long-term memory traces, perceptual, spatial, and auditory inputs and the semantic knowledge-base.

1.2. Executive Functions

Miyake et al. (2000) proposed three distinct categories of ExF: *shifting*, *updating*, and *inhibition*. Shifting refers to the executive control of attention (i.e. being able to switch back and forth between competing tasks); updating refers to the ability to mentally manipulate information held in working memory (e.g. perform novel calculations); and inhibition refers to the ability to inhibit inappropriate responses or cognitions. Executive control processes are thought to be able to modify the functioning of the episodic buffer by directing attention to various input sources from long-term memory, such as perceptual details and the semantic knowledge-base (Baddeley, 2000).

1.3. Associations Between AM, Working Memory, and Executive Function

The Constructive Model of AM (Conway & Pleydell-Pearce, 2000) predicts that executive control components of WM play a part in the generative retrieval of AMs, implicating both the phonological loop (e.g. Matuszewski et al., 2006) and the visuospatial sketchpad (e.g. Piolino et al., 2010). Previous research has generally supported the relationship between ExF, and to a lesser extent the episodic buffer, and AM retrieval. For example, results from traumatic brain injury (TBI), depression, and healthy ageing studies have suggested that impairments to updating and inhibition account for a significant proportion of the variance in participants' inability to continue hierarchical search of AM beyond the more general, semantic levels (Coste et al., 2010; Dalgleish et al., 2007; Ros, Latorre, & Serrano, 2010). A healthy ageing study also found the performance on a feature-binding task to account for a significant, albeit lesser amount of the variance (Piolino et al., 2010). In another study with healthy participants who were able to generate specific AMs, their performance was associated with measures of ExF and WM, supporting the role of these cognitive processes in AM retrieval (Unsworth, Spillers, & Brewer, 2012).

With the exception of Coste et al. (2010) and Piolino et al. (2010), the literature exploring the relationship between ExF and WM and AM has tended to use the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986) which does not allow for the measurement of "mental time travel" that must occur for the truly episodic reliving of phenomenological details (Matuszewski et al., 2006). This is a key limitation because it is possible that previous associations thought to occur between ExF or WM and episodic reliving may actually be relationships with event-specific, but still semantic AM. Furthermore, there is likely to be limited variation in the performance of cognitively healthy people on AM tasks which may result in ceiling effects (see Dritschel, Williams, Baddeley, & Nimmo-Smith, 1992; Kopelman, Wilson, & Baddeley, 1989; Piolino, Desgranges, Benali, & Eustache, 2002) and therefore limited scope for statistical analyses of these relationships due

to heavily skewed data which can lead to low statistical power (Rascati, Smith, & Neilands, 2001).

1.4. AM, Working Memory and Executive Function in AD

Several studies examining these relationships in AD samples have used phonemic and category fluency tasks, as these require the participant to search their semantic knowledgebase for words, inhibit inappropriate, "rule-break" (or repetitive) responses, and retrieve an appropriate, relevant response. According to the Constructive Model, these are abilities required in hierarchical search of AM.

Studies using a category fluency task have demonstrated a relationship with only semantic AM (Eustache et al., 2004; Moses, Culpin, Lowe, & McWilliam, 2004); with only episodic AM (Greene, Hodges, & Baddeley, 1995); with both semantic and episodic AM (Sartori, Snitz, Sorcinelli, & Daum, 2004); and one study found no relationship between category fluency and semantic nor episodic AM (Ivanoiu, Cooper, Shanks, & Venneri, 2006).

One study using a phonemic fluency task found relationships with both semantic and episodic AM (Greene et al., 1995), whilst two other studies found no relationships between phonemic fluency and either semantic or episodic AM (Ivanoiu et al., 2006; Moses et al., 2004).

The Greene et al. (1995) study also used dual performance tasks (Della Sala, Baddeley, Papagno, & Spinnler, 1995; Robertson, Nimmo-Smith, Ward, & Ridgeway, 1994) as measures of executive control, although their findings in terms of relationships with semantic and episodic AM were also mixed.

From the few studies that have reported correlational and predictive relationships between ExF, WM and AM, it appears that there is no clear consensus as to the contribution of these processes to the hierarchical search and retrieval of AMs in AD. A lack of consensus may be due to the different tasks that were used to assess ExF and WM across the different

studies, but also the type of measure used to assess AM. For example, the AMT only differentiates between general AM (more than one day) and specific AM (less than one day), and as such may not be a particularly valid measure of truly episodic AM.

1.5. Rationale

Therapeutic interventions in a care setting for people with AD will typically involve the use of verbal and visual cues for direct retrieval (e.g. photographs, or a particular piece of music), but if appropriate cues are not known or used then guided, generative retrieval methods may be beneficial as the person becomes more able to provide their own internal cues. Despite the importance of AM and self-defining memories for sense of self (Conway et al., 2004) and mood in general (Holland & Kensinger, 2010), the evidence for reminiscence or AM interventions in AD is weak (Woods, Spector, Jones, Orrell, & Davies, 2005), and the effects of current methods of cognitive training or rehabilitation in AD are unclear (Bahar-Fuchs, Clare, & Woods, 2013).

Understanding how AM is reconstructed cognitively is therefore important to inform and understand rehabilitative techniques and to establish a theory-linked evidence base for such interventions. The aim of this study was therefore to examine the relationships between ExF, WM, and semantic and episodic AM in a sample with a wide range of ability on tasks assessing these abilities, as this will have implications for cue-based rehabilitation strategies in AD and non-neurodegenerative conditions in which ExF and/or WM are compromised (e.g. depression or TBI).

1.6. Hypotheses

Based on Conway and Pleydell-Pearce's (2000) Constructive Model of AM, and findings from the literature reviewed above that suggest the importance of ExF and WM in episodic AM retrieval, the following hypotheses were generated:

H1: People with AD will retrieve fewer episodic AMs compared to controls.

H2: Verbal fluency and WM will be associated with the hierarchical search of semantic AM.

H3: Higher scores on verbal fluency and WM measures will be associated with increased episodic AM retrieval.

H4: Verbal fluency and WM will predict episodic AM retrieval, and mediate the effect of dementia status on episodic AM retrieval.

2. Method

2.1. Design

The study included both a between-groups comparison and a cross-sectional, correlational component. The between-groups design was chosen to allow comparisons between people with AD and healthy controls. The correlational design was chosen to allow associations between variables to be identified, for which the data were collapsed across the two groups to increase statistical power. To test Hypothesis 1, group (dementia status) served as the independent variable (IV) with AM, WM, and verbal fluency as the dependent variables (DVs) in the between-groups analysis. To test Hypothesis 2 and 3, verbal fluency, WM, semantic and episodic AM measures were chosen as variables in correlational analyses. To test Hypothesis 4, verbal fluency and WM measures served as the main predictors, with episodic AM as the DV in a regression model. For the mediation analysis, the predictor was dementia status (AD or control), with WM and verbal fluency measures as mediators, and episodic AM as the DV.

2.2. Participants

Recruitment involved the researcher travelling to five NHS sites across the South East of England and to participants' homes around these sites. Multiple sites were used so as to maximise recruitment opportunities and the representative nature of the sample. People with early-stage AD were identified by their hospital consultant as meeting the inclusion criteria, and were subsequently approached by the researcher. Given that only a short time since diagnosis had passed for some individuals, many understandably chose not to have their details passed to the researcher. As a result, a total of 10 participants with early-stage AD consented to take part. Partners or relatives of people presenting to the neurology/memory clinics were also approached to act as controls as they were more likely to be matched by age and education. Ten healthy controls took part.

Inclusion criteria for all participants included capacity (as per the Mental Capacity Act, [Department of Health, 2005]) to give written, informed consent, as a lack of capacity would be indicative of greater disease progression and likely wider cognitive impairment. As per the Mental Capacity Act, participants were assumed to have capacity unless there were indications to the contrary. These included being unable to understand, weigh, or communicate their decision to participate (Department of Health, 2005). It was also necessary for participants to be aged 18 years or older, and be fluent in English. People with AD were eligible for inclusion if their consultant considered them to have mild possible or probable AD and no other neurological illness following their clinical investigations (including an Mini Mental State Examination [MMSE] score of 18 or above [or equivalent]). People with a diagnosis under the age of 65 (i.e. young-onset AD) were included as this only differs by arbitrary age cut-off. Inclusion criteria for controls included no history of neurodegenerative disease. Exclusion criteria for both groups included significant

psychiatric history of severe mental illness (e.g. schizophrenia or bipolar diagnoses) or current treatment for a mental health condition.

2.3. Materials

2.3.1. General Cognitive Function

General cognitive function was screened for all participants using the Addenbrooke's Cognitive Examination – Revised (ACE-R; Mioshi, Dawson, Mitchell, Arnold, & Hodges, 2006), which contains within it the 30 items that comprise the Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). The ACE-R is a brief screening tool that assesses attention and orientation (18 points available), immediate and delayed verbal memory (26 points available), receptive and expressive language (26 points available), visuospatial and perceptual skills including constructional praxis (16 points available), and phonemic and category fluency as a measure of ExF (14 points available). Thus, a total of 100 points are available as an indication of general cognitive function, from which a cut-off of less than 88 yields 94% sensitivity and 89% specificity for dementia; and a cut-off of less than 82 yields 84% sensitivity and 100% specificity for dementia. The ACE-R has very good internal consistency reliability ($\alpha = .80$), and satisfactory concurrent and convergent validity ($r_s = -.32$, p[two-tailed] < .001) (Mioshi et al., 2006).

2.3.2. Working Memory

Auditory and spatial WM were assessed with the digit-span and spatial-span subtests from the Wechsler Memory Scale – Third Edition (WMS-III; Wechsler, 1998), respectively. The digit-span subtest requires participants to first listen to and repeat a list of numbers of increasing length in the "forwards" condition. This is followed by the

"backwards" condition, in which they must repeat the list of numbers in reverse order. The spatial-span subtest requires participants to watch and repeat increasing series of block-tapping sequences, first in the same order in the "forwards" condition, and then in reverse order in the "backwards" condition in a similar format to the digit-span. Both the WMS-III digit-span and spatial-span are well established, reliable measures of auditory and spatial WM (average reliability coefficients of .86 and .79, respectively; Wechsler, 1997).

More specifically, the forwards digit-span subtest was used as a measure of phonological capacity, whilst the backwards digit-span was used as a measure of executive control of auditory WM (Conway et al., 2005; Lezak et al., 2004). The use of forwards and backwards digit-spans as separate measures is common in the literature and consistent with arguments that they assess different aspects of WM (e.g. Reynolds, 1997). Similarly, the forwards spatial-span was used as a measure of spatial capacity, and backwards spatial-span as a measure of executive control of spatial WM.

2.3.3. Executive Function

The verbal fluency subscale of the ACE-R (see 2.3.1., above) was used as a measure of ExF required for generative retrieval (Mioshi et al., 2006). It requires participants to list as many words beginning with the letter "P" as possible, excluding proper nouns (phonemic fluency), and as many animals as possible (category fluency), each in 60 seconds. Correct responses are transformed into scaled scores (0-7), meaning a total scaled score of 14 is possible for the verbal fluency subscale. Single-letter phonemic fluency tasks have been shown to give similar results to multiple letter tasks (Barr & Brandt, 1996), including similar test-retest reliability to the gold standard F, A, and S phonemic fluency task (e.g. r = .73; Harrison, Buxton, Husain, & Wise, 2000). Thus, to strike a balance between participant

burden and reliable assessment, the ACE-R verbal fluency scale was used in place of a multi-letter fluency task.

2.3.4. Autobiographical Memory

A Verbal Autobiographical Fluency task (VAF; Piolino et al., 2010) was used to guide generative AM retrieval over four stages. In the first stage (VAF1), participants were asked to list as many general *life-periods* lasting three years or more (e.g. "living with Peter", or "caring for my mother"). Overlapping life-periods were permitted as per the original task instructions. In the second stage (VAF2), participants were asked to choose one of the general life-periods from VAF1 and list as many *general events* within the life-period that lasted several days or weeks (e.g. "our holiday to Italy", or "when I went to stay with my grandparents"). The third stage (VAF3) required participants to list as many *specific events* lasting from several minutes or hours up to a day, from within one VAF2 general event of choice (e.g. "my 10th birthday party", or "Sunday lunch with my aunt"). In the fourth and final stage (VAF4), participants were asked to provide *details* of a specific event or happening lasting no more than a few minutes, from within a VAF3 specific event of their choice. Responses for each stage were limited to two minutes, as per the original test instructions (Piolino et al., 2010).

Piolino et al. (2010) provide scoring criteria for VAF responses (see Appendix D), however the Autobiographical Interview (AI) scoring schedule (Appendix E; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002) was used to score episodic and semantic aspects of AM in the VAF4 condition, as this has been more widely validated in AD samples, including good inter-rater reliability, concurrent and convergent validity (Barnabe, Whitehead, Pilon, Arsenault-Lapierre, & Chertkow, 2012; Levine et al., 2002). The AI scores

truly episodic details (specific descriptions of the event, time, place, perceptions, thoughts or emotions) as "internal details". Details from other events, general semantic information, repetitions, or editorialising are scored as "external details". For this study, the episodic AM variable was the percentage of internal details in the total fluent response to the VAF4 condition[1]. Episodic AM was calculated in this way to control for differences in total fluent response on the VAF task. Thus, a lower percentage would be indicative of more generalised AM, predominantly semantic in nature, with higher percentages indicative of AM retrieval that is more episodic in nature. The original Piolino et al. (2010) scoring for VAFs 1-3 were still used as this a categorical judgement about whether the listed responses meet the inclusion criteria (i.e. "three years or more" for VAF1, etc.).

VAFs 1 and 2 have been shown to correlate significantly with semantic AM scores on the *Test Episodique de Mémoire du Passé autobiographique* (TEMPau) task, whilst scores on the VAF3 and to a greater extent, the VAF4, have been shown to correlate with episodic AM on the TEMPau, demonstrating concurrent, convergent and divergent validity in young and older-adult samples (Coste et al., 2010; Piolino et al., 2010). Thus, VAF1, 2 and 3 can be taken as measures of hierarchical search of semantic AM, and VAF4 a measure of event-specific semantic AM and "truly episodic" AM, as it was designed to elicit autonoesis. In this respect, VAF4 episodic AM might also be considered a proxy measure of episodic buffer functioning. In addition to these properties, verbal fluency tasks have been shown to avoid ceiling effects observed on some AM tasks in healthy controls (Greene & Hodges, 1996).

2.3.5. Additional Tests and Potentially Confounding Variables

In order to obtain more detailed group characteristics and control for potentially confounding variables several additional tests were administered.

[1] Total internal events / (internal + external events) * 100

2.3.5.1. Premorbid Intellectual Ability

The Wechsler Test of Adult Reading (WTAR; Wechsler, 2001) requires a list of 50 irregular words to be read, bypassing the reader's ability to use phonemes to generate the sound of the word. It is highly correlated (r = .73) with, and a significant predictor (β = .73, p < .01) of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997), and therefore represents a good estimate of optimal intellectual ability (Wechsler, 2001), especially as word naming is generally more resistant to the cognitive impairment associated with early AD . This was assessed so as to control for any effects of premorbid intelligence on task performance.

2.3.5.2. Semantic Knowledge

The Graded Naming Test (GNT; McKenna & Warrington, 1983) was used as an indicator of semantic knowledge for object names. The GNT is a stringent test of object naming able to detect small changes in cognitive function, with good test-retest reliability (r = .92) (Bird, Papadopoulou, Ricciardelli, Rossor, & Cipolotti, 2004).This was assessed to define the semantic naming abilities of the two groups for demographics purposes, and to control for any effects of semantic knowledge impairment on task performance.

2.3.5.3. Immediate Anterograde Memory

The Logical Memory I first recall score (LM1) from the WMS-III was used to assess narrative auditory memory for two short stories which are read once (Lichtenberger, Kaufman, & Lai, 2002) to establish group characteristics on this cognitive function. This was used in preference to the full Logical Memory I subtest, in which the second story is read

twice, to reduce participant burden. First-recall scaled scores were derived from the test manual according to the standardised procedure (Wechsler, 1998).

2.3.6.Mood

As mood has been linked to reduced episodic AM retrieval (e.g. Birch & Davidson, 2007), participants' recent mood states were assessed using the Depression Anxiety and Stress Scale – 21 item version (DASS-21; Lovibond, 1995). The DASS-21 was chosen in preference to the full DASS to reduce participant burden. The DASS-21 has been shown to have equivalent reliability to the full DASS (α = .88, .82, and .90 for the depression, anxiety and stress scales, respectively). The DASS-21 also has good convergent validity (*r* = .72-.78) validity when compared to other measures of depression and anxiety (Crawford & Henry, 2003; Henry & Crawford, 2005).

2.4. Statistical Analyses

Data were analysed with IBM SPSS (version 20). Parametric assumptions were checked for all variables prior to analysis (Appendices F and G). One outlier (a control participant's low score on the ACE-R) was identified as beyond two standard deviations (SDs) of the group mean (Clark-Carter, 2010; Field, 2009), however removal of this score from the analyses did not affect the significance of the results and so it was retained as there were no further justifications for its transformation or removal.

Correlations were explored with Pearson's product moment coefficients (*r*) for parametric data or Kendall's tau coefficients (τ) for non-parametric data. Kendall's tau was used in preference to Spearman's rho as it provides a more accurate estimation of the

population coefficient with smaller sample sizes (Howell, 2007), and it is more straightforward to conduct partial correlations with Kendall's tau (Clark-Carter, 2010). Correlations were conducted two-tailed.

Between-groups analyses were conducted using *t*-tests for parametric data or Mann-Whitney U tests for non-parametric data, and Cohen's *d* effect sizes calculated from the means and separate standard deviations (SDs). Cohen's (1988) recommendations for classifying effect sizes of .2, .5, and .8 as small, medium and large effects, respectively, were followed. Medians and ranges are presented in place of means and SDs for nonparametric comparisons. Predictive relationships were analysed using bootstrapped linear, multiple regression modelling with bias-corrected and accelerated (BCa) 95% confidence interval (CI) estimation. The bias-corrected bootstrap was selected as it is more highly powered than other bootstrap methods (Fritz & Mackinnon, 2007).

Bootstrapped mediation analysis with BCa 95% CI estimation was conducted using the Preacher and Hayes (2008) INDIRECT multiple mediation SPSS plug-in. Bootstrap resampling was set to 1000 (the minimum required; Preacher & Hayes, 2008). At least partial mediation is taken to occur if zero does not fall within the upper and lower CI bounds of the indirect effect of the mediator on the DV. Dementia status was chosen as the categorical predictor for the mediation analysis.

Power analyses to estimate the required sample size were conducted with reference to recommendations by Fritz and Mackinnon (2007) and Clark-Carter (2010). For all calculations the alpha level was set at 5% and power was set at 80% as recommended by Cohen (1990). *A priori* power analyses are described in Appendix H. A total sample of 20-25 participants was estimated for correlational analyses, and a total sample of 34 was estimated for the regression and mediation analyses.

2.5. Ethical Considerations and Procedure

Ethical approval for the study was obtained from an NHS Research Ethics Committee (see Appendix I). Site-approval was obtained from each Research and Development / Research Governance Office at the participating sites (see Appendix J). Written, informed consent was obtained from all participants following British Psychological Society (2010) research ethics guidelines.

Participants took part either at the recruitment site or at home (in accordance with Trust lone-working policy) if this was more convenient. The assessment battery was administered in its entirety unless participants became fatigued or the researcher suspected they were becoming uncomfortable or distressed. In these cases, participants were asked if they were uncomfortable or distressed, would like a break, to continue on another occasion, or to stop participation entirely. Their right to withdraw was re-emphasised at this point. No participants requested to withdraw, and for those who expressed fatigue, the battery was shortened for ethical reasons so as to obtain enough data for the main variables. Missing data are reported in the Results section. The AD participants took between one and two hours to complete the battery depending on the number of tests administered. The control participants took between one and one and-a-half hours, as they were generally quicker to complete the tasks. Where possible, data from tests administered during a recent clinical assessment were used to reduce participant burden. Responses to the VAF4 condition were recorded using a digital voice recorder for transcription and coding. All data were anonymised using participant numbers and kept in a locked cabinet separate to consent forms. Databases were password protected.

3. Results

3.1. Participant Demographics

Participant demographics are summarised in Table 1. The AD and control groups were well matched for age, education, premorbid intellectual ability, and mood scores, and so it was not planned to enter these variables as covariates in between-groups analyses. Significantly lower scores on the MMSE, ACE-R total, GNT, and LM1 for the AD group supported the validity of this group as a dementia sample.

Table 1

Group means on demographic variables (standard deviations in parentheses).

	AD	Controls	Test statistic	*p* value
n	10	10		
Age (in years)	66.2 (11.10)	61.4 (11.76)	$t = .94$	.360
Education (in years) [m]	11 (10-16)	10.5 (7-21)	$U = 45.5$	.724
Highest level of education (*n*)				
Primary School		1		
Secondary School (no qualifications)	4	1		
Secondary School (qualifications obtained)	1	4		
College / Sixth Form (A-levels or equivalent)	1	2		
Technical qualifications post school/college	3			
Undergraduate Degree(s)		1		
Doctorate		1		
Professional qualification	1			
Employment Status (*n*)				
Full-time	0	1		
Self-employed	0	1		

Part-time	1	3		
Retired	6	4		
Medically retired	1	1		
Ethnicity (*n*)				
Black British	1	0		
Black Caribbean	0	1		
Indian British	1	0		
Welsh	0	1		
White British	8	8		
Smoker (*n*)				
Never	7	7		
Not in last 10 years	2	2		
Current smoker	1	1		
Dominant Hand				
Right	10	9		
Trained from left to right	0	1		
Neuropsychological tests				
WTAR FSIQ	97.7 (8.03)	100.4 (9.3)	*t* = .70	.496
MMSE /30 [m]	20.5 (13-26)	29 (25-30)	*U* = 1.0	**.000**
ACE-R Total /100 [m]	65 (48-77)	94.5 (69-99)	*U* = 3.50	**.000**
GNT Percentile *	32.4 (29.63)	69.0 (30.44)	*t* = 2.65	**.017**
LM1 **	5.4 (3.26)	11.8 (3.12)	*t* = 4.07	**.001**
Mood Scales (DASS-21)				
Depression [m]	3 (0-20)	4 (0-30)	*U* = 41.5	.513
Anxiety [m]	3 (0-10)	1 (0-18)	*U* = 49.0	.937
Stress	8.6 (7.55)	11.6 (11.99)	*t* = .67	.512

Note. WTAR FSIQ = Wechsler Test of Adult Reading predicted Full Scale IQ. MMSE = Mini Mental State Examination. ACE-R = Addenbrooke's Cognitive Examination – Revised. GNT = Graded Naming Test. LM1 = Logical Memory 1 first recall.

[m] median and range presented

* 1 control missing data; ** 3 AD missing data

3.2. Potentially Confounding Variables

Age was negatively correlated with episodic AM, indicating that with increasing age, the episodic detail of retrieved AMs decreased (Table 2). Age was therefore entered as a covariate in correlational analyses of episodic AM. The only significant correlation for mood measures was between anxiety and search for general events (VAF2; Table 2), indicating that with increasing anxiety, the ability to retrieve general events from within a specified general life-period decreased, and so it was planned to control for anxiety in correlational analyses of VAF2.

3.3. Hypotheses 1

It was hypothesised that people with AD would retrieve fewer episodic AMs compared to controls. A t-test revealed that the AD group AMs had significantly less episodic content (M = 34.5%; SD = 27.63) compared to controls (M = 54.92%; SD = 17.64) (t[18] = 1.97, p[one tailed] = .03, d = .88).

3.4. Hypothesis 2

It was hypothesised that verbal fluency and WM would be associated with the hierarchical search of semantic AM. There was a trend for a moderate relationship between verbal fluency and hierarchical search for general life-periods, which was close to reaching significance (VAF1, Table 3; p = .058). A post-hoc power calculation with the G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009) indicated that this analysis was under-powered (52% power), suggesting that a larger sample may have detected a significant effect. However, there were no suggestions of relationships between verbal fluency and hierarchical search for general events within the selected life-period (VAF2, Table 3), or search for specific events within the general event (VAF3, Table 3). There were significant

associations between VAF1 score, and both backwards and total digit-span scores, indicating a relationship between auditory WM and hierarchical search for life-periods.

Table 2

Pearson's and Kendall's correlation coefficients (two-tailed) between potentially confounding variables and autobiographical memory (AM) measures.

	VAF1	VAF2	VAF3	VAF4 Episodic AM
Age (in years)	-.339	-.271	-.188 τ	**-.653****
Years in Education	.031 τ	.162 τ	.126 τ	.130 τ
WTAR FSIQ	.408	.425	.193 τ	-.052
DASS-21 Depression	-.023 τ	.024 τ	.101 τ	-.124 τ
DASS-21 Anxiety	-.341 τ	**-.366* τ**	-.027 τ	-.161 τ
DASS-21 Stress	-.097 τ	-.237 τ	-.012 τ	.082 τ

Note. DASS-21 = Depression, Anxiety and Stress Scale 21 Item Version. VAF = Verbal Autobiographical Fluency task.

Significant correlations in **bold type** for clarity.

* $p < .05$; ** $p < .01$

τ = Kendall's tau coefficient

Table 3

Pearson's and Kendall's correlation coefficients between the VAF task, and verbal fluency and WM measures

	Verbal Fluency	**Digit-Span Forwards**	**Digit-Span Backwards**	**Digit-Span Total**	**Spatial-Span Forwards** †	**Spatial-Span Backwards** †	**Spatial-Span Total** †
VAF1	.43	.18	**.45***	**.45***	.10	.25	.20
VAF2	.33	.29	.36	.40	.25	.19	.28
VAF3 τ	.13	.12	.27	.34	.08	.07	.08
VAF4 Episodic AM	**.45***§	.09	.15	.20	.08	.24	.19

* $p < .05$; Significant correlations in **bold type** for clarity.

τ Kendall's tau coefficients presented

† AD group missing data $n=3$

§ $r = .39$, $p = .10$ after controlling for age

3.5. Hypothesis 3

It was hypothesised that higher scores on verbal fluency and WM measures would be associated with greater episodic AM retrieval. Correlational analyses (Table 3, above) revealed a significant relationship between verbal fluency and episodic AM. A planned, partial correlation was conducted to control for the effect of age on this relationship, which diminished its significance (r = .391, p = .10). Neither auditory WM capacity (forwards digit-span) nor executive control of auditory WM (backwards digit-span) were associated with episodic AM (both ps > .05). Similarly, neither spatial WM capacity (forwards spatial-span) nor executive control of spatial WM (backwards spatial-span) were associated with episodic AM (both ps > .05).

3.6. Hypothesis 4

It was hypothesised that verbal fluency and WM would predict greater episodic AM retrieval, and mediate the effect of dementia status on episodic AM retrieval. As only verbal fluency (and not WM) was correlated with episodic AM, this was entered into a hierarchical regression model as a single predictor of episodic AM. Statistical assumptions for linear regression (Field, 2009) were all met (Appendix M).

Verbal fluency was a significant predictor (β = .45, p < .05), with the model accounting for approximately 16% of the variance (F[1, 18] = 4.68, p < .05). As age was also significantly associated with the episodic AM total, a second, exploratory regression model was run with both fluency and age entered as predictors over two steps (Table 4). Age contributed a further 31% of the variance. 95% CIs for both variables did not span zero, and thus both variables could be considered independent, significant predictors of episodic AM,

with stronger verbal fluency predicting greater episodic AMs, and increasing age predicting fewer episodic AMs.

Table 4

Regression coefficients for predictors of VAF4 episodic AM with bias-corrected and accelerated 95% confidence intervals (BCa CIs).

							BCa 95% CI	
Step 1	R_{Adj}^2	ΔR^2	*b*	S.E.†	*p* value	β	Lower	Upper
ACE-R Verbal Fluency	.162	-	4.01	1.25	.004	.45	1.62	28.94
Step 2								
ACE-R Verbal Fluency	.458	.206	2.71	.87	.012	.31	.485	4.533
Age (in years)		.308	-1.25	.24	.001	-.56	-1.714	-.757

†Based on 1000 bootstrap samples

Finally, to test the constructive AM model, the theoretically predicted mediators of episodic AM (auditory and spatial WM, and verbal fluency) were entered in a mediation analysis. To increase the power of this analysis, the forwards and backwards conditions of the WM tasks were combined into their respective digit-span, and spatial-span total scaled scores according to standardised procedure (Wechsler, 1998) and these two variables were entered as WM measures in the mediation analysis. Mediation analyses were conducted with a sample of N=17 due to missing spatial-span data from three AD participants. All β coefficients are reported controlling for age due to its association with the episodic AM.

The model indicated that dementia status significantly predicted scores on verbal fluency and WM tasks. Of these tasks, only verbal fluency significantly mediated the effect

of dementia status on episodic AM (BCa 95% CIs -56.07 to -6.28). Importantly, this appeared to be independent of age, the partial effects of which were also significant (β = -.87, $p < .05$). Furthermore, the direct effect of dementia status on episodic AM was not significant (Figure 1), lending increased support to the mediation hypothesis. In summary the data were consistent with the possibility that the episodic content of retrieved AMs decreased as a function of dementia status due to weaker verbal fluency, independent of the effects of ageing; auditory or spatial WM were not significant mediators (Figure 1).

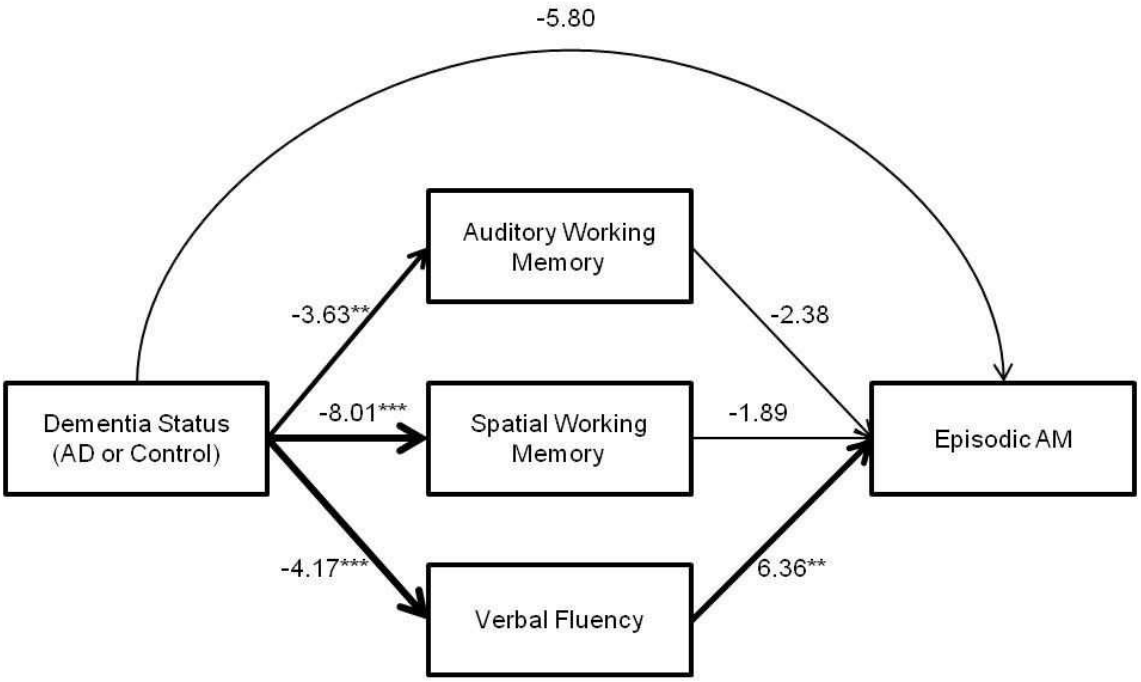


Figure 1. Mediation model for VAF4 episodic AM. Coefficients are β values.

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

4. Discussion

Previous research examining the role of ExF and WM in semantic and episodic AM retrieval has not generated consensus as to the level of contribution of these functions to these abilities, hampered by skewed data and ceiling effects in healthy ageing samples. Lack of clear findings may also be attributable to the insufficient measurement of episodic AM by

some tasks, and the different approaches to measuring ExF and WM. Therefore this study sought to examine the relationship between verbal fluency and WM and the episodic content of retrieved AMs , as predicted by the Constructive Model (Conway & Pleydell-Pearce, 2000), in a sample with a wide range of abilities on the cognitive tasks, using a new, arguably better test of autobiographical fluency previously unused with an AD sample.

4.1. The Role of Working Memory and Verbal Fluency in Hierarchical Search

It was hypothesised that hierarchical search of semantic AM (VAF1-3) would be associated verbal fluency and WM. There was a significant, strong relationship between backwards and total digit-span scores and search for general life-periods (VAF1), which is consistent with previous, well-powered research (Coste et al., 2010; Piolino et al., 2010) that also demonstrated a relationship between a verbal WM measure and the VAF1 condition but not other AM measures. However, the present study found no relationship between spatial WM and hierarchical search stages, which is in contrast to previous research in healthy ageing (Piolino et al., 2010) which found moderate to strong correlations with VAF2 and 3. This could have been due to low statistical power; however the relationships with spatial-span scores did not even approach significance, and so it is possible that this conflicting finding might be due to a different pattern of spatial WM observed in this sample which included people with AD.

There was only a trend for a moderate relationship between verbal fluency and the VAF1 condition. This result should be interpreted with caution, as it is possible the lack of significance was due to a Type II error due to low statistical power to detect a smaller effect. Previous research has found associations between auditory inhibition and hierarchical search (Piolino et al., 2010). Thus, if a future study was able to detect a significant relationship between verbal fluency and VAF1, but not VAF2 or 3, this may reflect the fact

that initiating the hierarchical search at the most general level requires the most cognitive effort, after which access to relevant semantic knowledge becomes less demanding.

4.2. The Role of Working Memory and Verbal Fluency in Episodic AM Retrieval

The third hypothesis predicted a relationship between episodic AM and both verbal fluency and WM measures. No significant relationships were established between spatial WM and episodic AM. This was surprising given that mentally reliving events from the past appears to require holding spatial information in mind. As the AD group appeared to be quite impaired on this task, it is possible that the restricted range of scores in the AD group prevented an existing relationship from being established in this sample. Indeed, previous research has found strong, significant correlations between spatial WM and episodic AM in healthy ageing and TBI samples (Coste et al., 2010; Piolino et al., 2010). Future research might include a measure of spatial fluency to determine whether spatial reliving is associated with more on-line, fluent retrieval processes rather than short-term spatial storage.

It would be tempting to conclude that the strong positive correlation between verbal fluency and episodic AM was simply due to the nature of the AM task used here as a verbal fluency task itself. However because episodic AM was calculated as a percentage of total episodic and semantic productions, thus controlling for differences in total fluent responses; this suggests that weaker verbal fluency results in AM that is more semantic in nature, at the expense of episodic detail. Indeed, the AMs retrieved by the AD group were significantly less episodic in nature compared to the control group and this effect was large.

Multiple regression analysis and mediation modelling supported the role of verbal fluency in retrieval of episodic AM, independent of age. One possible interpretation of this result is that it is necessary to continue to search the event-specific knowledgebase and update the episodic buffer during episodic re-construction (rather than all

phenomenological details becoming available at once), and that weaker verbal fluency means that this process is limited. This is consistent with the hierarchical nature of AM search and retrieval predicted by the Constructive Model (Conway & Pleydell-Pearce, 2000). However, verbal fluency and age combined accounted for just under half the variance in episodic AM retrieval, suggesting that other processes are equally as important for episodic reliving, such as medial-temporal lobe feature-binding which is impaired in AD (Parra, Abrahams, Fabi, Logie, Luzzi, & Della Sala, 2009; Parra, Abrahams, Logie, & Della Sala, 2010; Parra, Abrahams, Logie, Méndez, Lopera, & Della Sala, 2010) but was not assessed in the present study and remains to be investigated.

This study attempted to statistically model the constructive nature of AM according to Conway and Pleydell-Pearce's (2000) model using mediation analysis. Despite the lack of significant relationships between WM variables and AM, these were force-entered alongside verbal fluency as mediators on a theoretical basis. The final model partially supported the fourth hypothesis in that verbal fluency was a significant mediator of dementia status on episodic AM. WM variables however, did not mediate the effect of dementia status on episodic AM retrieval. Importantly, these results were controlled for age, and so they might be considered independent of the typical effects of ageing on general cognitive function and memory.

4.3. Theoretical Implications

The implications of these findings for the constructive model of AM are two-fold. Firstly, they appear to suggest that the decline in phonological and visuospatial WM associated with AD is not associated with the ability to retrieve episodic AMs, despite previous findings that WM capacity is related to strategic search of the event-specific knowledgebase (Unsworth et al., 2012). Secondly, if the VAF task is to be considered a proxy measure of the function of the episodic buffer proposed by Baddeley (2000), then either the

buffer itself (proposed to comprise of parietal cortical networks [Vilberg & Rugg, 2008]) is responsible for binding phenomenological details via search and retrieval, (in contrast to recent evidence; Allen et al., 2012; Baddeley et al., 2011), or non-conscious medial-temporal lobe feature-binding (Pertzov et al., 2013) occurs prior to representation in the buffer.

The finding that AM becomes more semantic in nature in AD, mediated by weaker verbal fluency, is also consistent with the theory of overgeneral AM in the context of weaker ExF (Sumner et al., 2011).

4.4. Methodological Considerations

The total sample size reached fell short of that estimated in the *a priori* power calculations (Appendix H). This precluded correlational analyses by group, which would be useful to look at in future research with a larger sample as different patterns of relationships have been found previously between AD and control groups (e.g. Moses et al., 2004). The recruitment of people with early-stage AD proved to be more difficult than initially anticipated, largely due to ethical considerations (such as people not being ready to participate due to recent diagnosis; or some tests being omitted to avoid fatigue or discomfort). This was unfortunate, but the ethics of such research must be prioritised above the need to recruit to estimated numbers. It may be worth conducting a similar study to the present one with a larger sample to explore the more subtle relationships between WM and hierarchical search; however given that this study found several patterns of results consistent with previous, well-powered studies (e.g. Piolino et al., 2010), future studies will need to consider carefully how aspects of WM are assessed. For example, whilst WM span tasks measure the ability to manipulate information in short-term memory, episodic AM may not depend so much on this ability (as demonstrated in the present study), compared to tasks designed to measure on-line updating of the episodic buffer (such as verbal and visual fluency tasks). In support of this hypothesis, Piolino et al. (2010) found significant weak,

moderate and strong correlations between such tasks and various stages of hierarchical search and AM retrieval in a healthy ageing sample.

Although regression and mediation modelling were used in this study, it is important to note the limitations of these approaches. Whilst they attempt to statistically attribute causal effects, it is not possible to infer causality from a correlational design.

The two groups presented here were well matched for age, education, premorbid intellectual ability, and culturally very similar, which reduces the chance that the effects observed in this study were due to confounding factors. This is important given that the implications of these results for clinical practice will now be addressed.

4.5. Clinical Implications

The lack of a relationship between WM measures, and hierarchical search of semantic AM and episodic AM retrieval, and the demonstrated relationship between verbal fluency and episodic AM retrieval, have important implications for AM-based therapeutic and rehabilitative strategies in early AD. Firstly, these findings suggest that memory training (e.g. internal strategies such as chunking, word-association, or spaced rehearsal for AMs) may not assist in improving AM retrieval per se. This is consistent with the existing weak evidence for such interventions in dementia (Bahar-Fuchs et al., 2013).

Secondly, it seems likely that guided hierarchical search with external support could facilitate the generative retrieval process in those with weaker fluent retrieval, making semantic access easier, and potentially increasing the episodic content of AM than would occur otherwise. Such external support could include the use of structured life-story booklets (or electronic aids), collaboratively made with people in the earlier stages of AD, that follow the hierarchical search strategy. For example, each chapter could start with visual and verbal details of important life-periods and subsequently focus on more event-specific information over the subsequent pages. It is possible that continued reference to a

structured booklet in this way over the course of neurodegenerative conditions might prolong the working-self, and thus the person's sense of self and wellbeing for longer. Given the paucity of evidence for reminiscence therapy in dementia (Woods et al., 2005), a more structured format following the principles of generative retrieval may help to increase the benefits received by those taking part, and lead to more consistent outcomes.

4.6. Future Research

Future studies could aim to evaluate the use of structured life-story booklets or aids with people with AD, or other executive impairment resulting in reduced access to AM. These studies could evaluate improvements in wellbeing or performance on cognitive tests. Other studies might continue to examine how semantic and episodic AM contribute differentially to wellbeing in people with dementia and/or other neurological conditions where AM is impaired. Rehearsal of personal semantic knowledge may be enough to prolong sense of self in people with neurodegenerative conditions, or rehabilitate it in persons with TBI or depression, and randomised trials should be designed to test the efficacy of more structured reminiscence therapy groups to test whether these would be beneficial for people with AM impairment. To further understanding of cognitive processes involved in AM retrieval, future research might look at the relative contributions of fluency and feature-binding tasks to episodic AM retrieval in combination with functional imaging.

5. Conclusion

To the best of the author's knowledge, the present study is the first to examine the relative contributions of auditory and spatial WM, and verbal fluency to truly episodic AM retrieval in a sample of participants with AD and matched controls. Verbal fluency significantly predicted truly episodic AM, independent of age effects. A mediation analysis designed to test the Constructive Model of AM revealed that weaker verbal fluency

mediated a reduction in episodic AM as a function of dementia status. The results suggest that auditory and spatial WM play only a very limited role in AM search and retrieval in AD, and that therapeutic strategies should focus on providing external support for the fluent retrieval process to enable greater semantic and possibly episodic AM retrieval in those with AM impairments.

References

Allen, R. J., Hitch, G. J., Mate, J., & Baddeley, A. D. (2012). Feature binding and attention in working memory: A resolution of previous contradictory findings. *Quarterly Journal of Experimental Psychology*, *65*(12), 2369–83. doi:10.1080/17470218.2012.687384

Almkvist, O. (1996). Neuropsychological features of early Alzheimer's disease: Preclinical and clinical stages. *Acta Neurologica Scandinavica*, *165*(Supplementum), 63–71.

Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, *4*(11), 471–423. doi:10.1016/S1364661300015382

Baddeley, Alan D, Allen, R. J., & Hitch, G. J. (2011). Binding in visual working memory: The role of the episodic buffer. *Neuropsychologia*, *49*(6), 1393–400. doi:10.1016/j.neuropsychologia.2010.12.042

Bahar-Fuchs, A., Clare, L., & Woods, B. (2013). Cognitive training and cognitive rehabilitation for mild to moderate Alzheimer's disease and vascular dementia. *Cochrane Database of Systematic Reviews*, *6*, CD003260. doi:10.1002/14651858.CD003260.pub2

Barnabe, A., Whitehead, V., Pilon, R., Arsenault-Lapierre, G., & Chertkow, H. (2012). Autobiographical memory in mild cognitive impairment and Alzheimer's disease: A comparison between the Levine and Kopelman interview methodologies. *Hippocampus*, *22*(9), 1809–25. doi:10.1002/hipo.22015

Barr, A., & Brandt, J. (1996). Word-list generation deficits in dementia. *Journal of Clinical and Experimental Neuropsychology, 18*(6), 810-822.

Birch, L. S., & Davidson, K. M. (2007). Specificity of autobiographical memory in depressed older adults and its relationship with working memory and IQ. *British Journal of Clinical Psychology, 46*(2), 175-186.

Bird, C. M., Papadopoulou, K., Ricciardelli, P., Rossor, M. N., & Cipolotti, L. (2004). Monitoring cognitive changes: Psychometric properties of six cognitive tests. *The British Journal of Clinical Psychology*, *43*(2), 197–210. doi:10.1348/014466504323088051

British Psychological Society. (2010). *Code of Human Research Ethics.* Leicester: British Psychological Society.

Clark-Carter, D. (2010). *Quantitative Psychological Research* (3rd Ed.). Hove, East Sussex: Psychology Press.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences* (2nd ed). New York: Academic Press.

Cohen, J. (1990). Things I have learned so far. *American Psychologist*, *45*, 1304–1312.

Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin & Review*, *12*(5), 769–86.

Conway, M. A. (1990). *Autobiographical Memory*. Buckingham: Open University Press.

Conway, M. A., & Fthenaki, A. (2000). Disruption and loss of autobiographical memory. In: L. S. Cermak (Ed.), *Handbook of Neuropsychology: Memory and its Disorders* (2nd ed., pp. 281–312). Amsterdam: Elsevier.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, *107*(2), 261–288. doi:10.1037//0033-295X.

Conway, M. A., Singer, J. A., & Tagini, A. (2004). The self and autobiographical memory: Correspondence and coherence. *Social Cognition*, *22*(5), 491–529. doi:10.1521/soco.22.5.491.50768

Corsi, P. M. (1972). Human memory and the medial temporal region of the brain. *Dissertation Abstracts International*, *34*(02), 891B. (University Microfilms No. AAI05–77717).

Coste, C., Agar, N., Petitfour, E., Quinette, P., Guillery-Girard, B., Azouvi, P., & Piolino, P. (2010). Exploring the roles of the executive and short-term feature-binding functions in retrieval of retrograde autobiographical memories in severe traumatic brain injury. *Cortex*, *47*(7), 771–86. doi:10.1016/j.cortex.2010.07.004

Crawford, J. R., & Henry, J. D. (2003). The Depression Anxiety and Stress Scales (DASS): Normative data and latent structure in a large non-clinical sample. *British Journal of Clinical Psychology, 42*, 111-131.

Dalgleish, T., Williams, J. M. G., Golden, A.-M. J., Perkins, N., Barrett, L. F., Barnard, P. J., Yeung, C. A., et al. (2007). Reduced specificity of autobiographical memory and depression: The role of executive control. *Journal of Experimental Psychology. General*, *136*(1), 23–42. doi:10.1037/0096-3445.136.1.23

Della Sala, S., Baddeley, A. D., Papagno, C., & Spinnler, H. (1995). Dual-Task Paradigm: A Means To Examine the Central Executive. *Annals of the New York Academy of Sciences*, *769*(1), 161–172. doi:10.1111/j.1749-6632.1995.tb38137.x

Department of Health Mental Capacity Act (2005). London.

Dritschel, B. H., Williams, J. M. G., Baddeley, A. D., & Nimmo-Smith, I. (1992). Autobiographical fluency: A method for the study of personal memory. *Memory & Cognition*, *20*(2), 133–140. doi:10.3758/BF03197162

Eustache, F., Piolino, P., Giffard, B., Viader, F., De La Sayette, V., Baron, J.-C., & Desgranges, B. (2004). "In the course of time": A PET study of the cerebral substrates of autobiographical amnesia in Alzheimer's disease. *Brain*, *127*(7), 1549–60. doi:10.1093/brain/awh166

Fargeau, M. N., Jaafari, N., Ragot, S., Houeto, J. L., Pluchon, C., & Gil, R. (2010). Alzheimer's disease and impairment of the Self. *Consciousness and Cognition*, *19*(4), 969–76. doi:10.1016/j.concog.2010.06.014

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–60. doi:10.3758/BRM.41.4.1149

Field, A. (2009). *Discovering Statistic Using SPSS* (3rd ed). London: Sage.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini Mental State": A practical method for grading the cognitive state of patients for the clinician. *Psychiatric Research*, *12*, 189–198.

Fritz, M. S., & Mackinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science*, *18*(3), 233–9. doi:10.1111/j.1467-9280.2007.01882.x

Greene, J. D. W., & Hodges, J. R. (1996). The fractionation of remote memory. *Brain*, *119*(1), 129–142. doi:10.1093/brain/119.1.129

Greene, J. D. W., Hodges, J. R., & Baddeley, A. D. (1995). Autobiographical memory and executive function in early dementia of Alzheimer type. *Neuropsychologia*, *33*(12), 1647–1670. doi:10.1016/0028-3932(95)00046-1

Harrison, J., Buxton, P., Husain, M., & Wise, R. (2000). Short test of semantic and phonological fluency: Normal performance, validity and test-retest reliability. *British Journal of Clinical Psychology, 39*(2), 181-191.

Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*, *44*(2), 227–39. doi:10.1348/014466505X29657

Holland, A. C., & Kensinger, E. A. (2010). Emotion and autobiographical memory. *Physics of Life Reviews*, *7*(1), 88–131. doi:10.1016/j.plrev.2010.01.006

Howe, M. L. (2011). *The Nature of Early Memory*. New York: Oxford University Press.

Howell, D. C. (2007). *Statistical Methods for Psychology* (6th ed). Belmont, CA: Thomson/Wadsworth.

Ivanoiu, A., Cooper, J. M., Shanks, M. F., & Venneri, A. (2006). Patterns of impairment in autobiographical memory in the degenerative dementias constrain models of memory. *Neuropsychologia*, *44*(10), 1936–55. doi:10.1016/j.neuropsychologia.2006.01.030

Kopelman, M. D., Wilson, B. A., & Baddeley, A. D. (1989). The autobiographical memory interview: A new assessment of autobiographical and personal semantic memory in amnesic patients. *Journal of Clinical and Experimental Neuropsychology*, *11*(5), 724–744. doi:10.1080/01688638908400928

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging*, *17*(4), 677–89.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological Assessment* (4th ed.). Oxford: Oxford University Press.

Lichtenberger, E. O., Kaufman, A. S., & Lai, Z. C. (2002). *Essentials of WMS-III Assessment.* New York: John Wiley & Sons

Lovibond, P. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, *33*(3), 335–343. doi:10.1016/0005-7967(94)00075-U

Matuszewski, V., Piolino, P., De la Sayette, V., Lalevée, C., Pélerin, A., Dupuy, B., Viader, F., et al. (2006). Retrieval mechanisms for autobiographical memories: Insights from the frontal variant of frontotemporal dementia. *Neuropsychologia*, *44*(12), 2386–97. doi:10.1016/j.neuropsychologia.2006.04.031

McKenna, P., & Warrington, E. K. (1983). *Graded Naming Test Manual*. Windsor: NFER-Nelson.

Mioshi, E., Dawson, K., Mitchell, J., Arnold, R., & Hodges, J. R. (2006). The Addenbrooke's Cognitive Examination Revised (ACE-R): A brief cognitive test battery for dementia screening. *International Journal of Geriatric Psychiatry*, *21*(11), 1078–85. doi:10.1002/gps.1610

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. doi:10.1006/cogp.1999.0734

Moscovitch, M., Yaschyshyn, T., Ziegler, M., & Nadel, L. (1999). Remote episodic memory and retrograde amnesia: Was Endel Tulving right all along? In: E. Tulving (Ed.), *Memory, Consciousness, and The Brain: The Tallinn Conference* (pp. 331–345). Psychology Press.

Moses, A., Culpin, V., Lowe, C., & McWilliam, C. (2004). Overgenerality of autobiographical memory in Alzheimer's disease. *British Journal of Clinical Psychology*, *43*(4), 377–86. doi:10.1348/0144665042388964

Nestor, P. J., Graham, K. S., Bozeat, S., Simons, J. S., & Hodges, J. R. (2002). Memory consolidation and the hippocampus: Further evidence from studies of autobiographical memory in semantic dementia and frontal variant frontotemporal dementia. *Neuropsychologia*, *40*(6), 633–54.

Parra, M. A., Abrahams, S., Fabi, K., Logie, R., Luzzi, S., Della Sala, S. (2009). Short-term memory binding deficits in Alzheimer's disease. *Brain, 132*, 1057-1066.

Parra, M. A., Abrahams, S., Logie, R. H., & Della Sala, S. (2010). Visual short-term memory binding in Alzheimer's disease and depression. *Journal of Neurology, 257*, 1160-1169.

Parra, M. A., Abrahams, S., Logie, R., Méndez, L. G., Lopera, F., & Della Sala, S. (2010). Visual short-term binding deficits in familial Alzheimer's disease. *Brain, 133,* 2702-2713.

Pertzov, Y., Miller, T. D., Gorgoraptis, N., Caine, D., Schott, J. M., Butler, C., & Husain, M. (2013). Binding deficits in memory following medial temporal lobe damage in patients with voltage-gated potassium channel complex antibody-associated limbic encaphalitis. *Brain*, ePub ahead of print. doi:10.1093/brain/awt129

Piolino, P., Desgranges, B., Benali, K., & Eustache, F. (2002). Episodic and semantic remote autobiographical memory in ageing. *Memory*, *10*(4), 239–257.

Piolino, P, Coste, C., Martinelli, P., Macé, A.-L., Quinette, P., Guillery-Girard, B., & Belleville, S. (2010). Reduced specificity of autobiographical memory and aging: Do the executive and feature binding functions of working memory have a role? *Neuropsychologia*, *48*(2), 429–40. doi:10.1016/j.neuropsychologia.2009.09.035

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891. doi:10.3758/BRM.40.3.879

Rascati, K. L., Smith, M. J., & Neilands, T. (2001). Dealing with skewed data: An example using asthma-related costs of medicaid clients. *Clinical Therapeutics*, *23*(3), 481–498. doi:10.1016/S0149-2918(01)80052-7

Reynolds, C. (1997). Forward and backward memory span should not be combined for clinical analysis. *Archives of Clinical Neuropsychology, 12*(1), 29-40.

Robertson, I. H., Nimmo-Smith, I., Ward, T., & Ridgeway, V. (1994). *Test of Everyday Attention*. Bury St Edmunds: Thames Valley Test Company.

Ros, L., Latorre, J. M., & Serrano, J. P. (2010). Working memory capacity and overgeneral autobiographical memory in young and older adults. *Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition*, *17*(1), 89–107. doi:10.1080/13825580903042650

Sartori, G., Snitz, B. E., Sorcinelli, L., & Daum, I. (2004). Remote memory in advanced Alzheimer's disease. *Archives of Clinical Neuropsychology*, *19*(6), 779–89. doi:10.1016/j.acn.2003.09.007

Sumner, J. A., Griffith, J. W., & Mineka, S. (2011). Examining the mechanisms of overgeneral autobiographical memory: Capture and rumination, and impaired executive control. *Memory*, *19*(2), 169–83. doi:10.1080/09658211.2010.541467

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology*, *26*, 1–12.

Unsworth, N., Spillers, G. J., & Brewer, G. A. (2012). The role of working memory capacity in autobiographical retrieval: Individual differences in strategic search. *Memory*, *20*(2), 167–76. doi:10.1080/09658211.2011.651087

Vilberg, K. L., & Rugg, M. D. (2008). Memory retrieval and the parietal cortex: A review of evidence from a dual-process perspective. *Neuropsychologia, 46*(7), 1787-1799. doi:10.1016/j.neuropsychologia.2008.01.004

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale* (3rd ed.). London: The Psychological Corporation.

Wechsler, D. (1997). *Wechsler Memory Scale. Technical Manual* (3rd ed). London. The Psychological Corporation.

Wechsler, D. (1998). *Wechsler Memory Scale. Test Manual* (3rd ed.). London: The Psychological Corporation.

Wechsler, D. (2001). *Wechsler Test of Adult Reading. Test Manual*. San Antonio, TX: The Psychological Corporation.

Williams, J. M., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *Journal of Abnormal Psychology*, *95*(2), 144–149. doi:10.1037/0021-843X.95.2.144

Woods, B., Spector, A., Jones, C., Orrell, M., & Davies, S. (2005). Reminiscence therapy for dementia. *Cochrane Database of Systematic Reviews*, (2), CD001120. doi:10.1002/14651858.CD001120.pub2

Maxwell James Benjamin B.Sc. (Hons)., M.Sc.

Major Research Project

Section C: Critical Appraisal

Word count: 1931

September 2013

SALOMONS

CANTERBURY CHRIST CHURCH UNIVERSITY

Critical Appraisal

Following the Literature Review and Empirical Study, a critical appraisal of the research process now follows, with reference to four specific questions posed by the clinical training programme.

1. **What research skills have you learned and what research abilities have you developed from undertaking this project and what do you think you need to learn further?**

This was the first time I had conducted a literature review on a large scale. I therefore had to learn how to conduct a satisfactorily systematic search across multiple platforms, learn about quality assessment, and how to synthesise and present the subsequently identified literature. Useful resources included the Cochrane Handbook for Systematic Review (Higgins & Green, 2011) which contains detailed guidelines on conducting a systematic search. Memory, and specifically autobiographical memory, is a vast topic with research dating back many years, and so it was certainly a challenge to become familiar with the research base to an extent where it was possible to be selective about what to include. Forming specific research questions in collaboration with supervisors was perhaps the most helpful approach to refining the literature review as it enabled me to focus on the literature that really mattered to answering the review's questions, which in turn makes any review more palatable to the reader.

Although I have had previous experience of designing an experimental study during my undergraduate degree, this was the first time I had formulated and designed an empirical study including the extensive NHS research ethics service (NRES) application procedure. The NRES process was thorough, and this helped me to really think about the

ethical implications of my study and how, as a professional researcher, I would respond to various ethical scenarios (such as mental capacity, participant distress and my duty of care).

To answer my research questions, I needed to become familiar with new statistical procedures, including mediation analysis and the theoretical basis on which this can be carried out. This included learning about the assumptions that needed to be met by that data and how to interpret statistical outputs. Whilst it was interesting to learn more about these aspects of methodology, it did make me more aware of how much more there is to know about quantitative data analysis. I would be interested to learn further about statistical techniques including structural equation modelling, as I believe that these more complex analyses will be useful for future research in public health, which is an ongoing interest of mine. In future, I would also like the opportunity to develop skills in single-case and case-series designs, where it might be possible to incorporate qualitative methods, such as content analysis, to enrich the outcomes of such research.

At various stages of the research process I have been required to explain and justify my study to experts and lay audiences alike, from the proposal review process through to the ethics panel meeting, to a Research Net service user representative and to the participants as part of the informed consent process. I believe this was one of my greatest areas of development over the course of this research as it required me to grasp quite technical and complex cognitive neuropsychology concepts and their clinical implications; but also to communicate these in a way that could be understood by lay persons.

2. If you were able to do this project again, what would you do differently and why?

Whilst I believe this study had several strengths, including the use of a more valid task to assess episodic autobiographical memory, and mediation modelling to statistically

test a theoretical model; there are some aspects of the study that I would change with hindsight. Recruiting participants proved to be particularly challenging during this study, especially as a lot of time was involved in the recruitment, assessment (one to two hours) and travel to sites across the South East of England. I had underestimated how much of a struggle it would be to balance ongoing clinical placements and other assignments with completion of this project.

Furthermore, it became apparent during liaison with the site consultants that it was too early to approach some of their patients to participate as they had received a diagnosis recently and would understandably need time to adjust to this. If I was able to do this project again, I would also recruit from non-clinical population samples as well as the clinics. For example, the Alzheimer's Society often run "dementia cafes" and these may have been suitable to approach people about participation. This may have resulted in being able to assess more participants in the timeframe available, and better statistical power. Unfortunately it was not possible to do this in the present study as it would have required a substantial amendment to the ethical approval which would not have been obtained within the timescale of the research submission. However, in order to obtain greater statistical power, it is my intention to continue collecting data until the end of the programme, and hence why the included NRES End of Study Notification form (Appendix S) is included but not complete with the end date.

I employed a number of measures in order to help control for various cognitive functions and this meant that the assessment battery was quite long, and I noticed that many participants tired after an hour. I would therefore have chosen to shorten the battery (although this was done to some extent for those who didn't want to do all the tests). For instance, it would have been possible to omit the Logical Memory subtest (Wechsler, 1998) and Graded Naming Test (McKenna & Warrington, 1983) and acknowledge the limitation of not quantitatively controlling for immediate anterograde memory or object naming.

Despite the established inter-rater reliability of the Autobiographical Interview scoring criteria (AI; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Appendix E), it would have been useful to have calculated inter-rater reliability for this study. It is my intention to do this for publication purposes by asking another independent rater to score a proportion of the participant responses on the AI.

I would have liked to have assessed AMs across all life-periods in order to examine the pattern of truly episodic memories from across the lifespan. This would have enabled me to test theories of long-term memory consolidation (Alvarez & Squire, 1994; Nadel & Moscovitch, 1997) in addition to the Constructive Model of AM (Conway & Pleydell-Pearce, 2000). However, to do so would have increased the assessment time with each participant, and it would have broadened the topic so that it was not manageable or realistic in the timeframe available.

3. <u>Clinically</u>, as a consequence of doing this study, would you do anything differently and why?

Although I was aware of how dementia can affect family relationships and quality of life, this study has made me even more aware of the specific impact of the loss of past, personal memories, and just how difficult this must be for loved ones of those with dementia, and how confusing and frightening it must be for the individual. Participants from both groups commented that they were pleasantly surprised at what they were able to remember, and I consider it a privilege to have been able to share in their personal memories. I hope that this insight will help me in my work with couples and families where an individual has dementia, particularly in terms of memory rehabilitation. Helping families construct individualised memory aids and life-story booklets for the person with dementia can be a time-intensive intervention; however I believe that this study lends provisional empirical support to such clinical work.

The study has made me even more aware of the need for satisfactory support for carers, many of whom do not know how or where to ask for assistance. If carer support is offered by NHS services it is often limited to brief counselling and signposting for social care support. Memory service development as part of the National Dementia Strategy in England and Wales (Department of Health, 2009) has meant that carers can access more support than perhaps previously, and this project has highlighted the potential benefits of structured reminiscence groups that could take place within these services. Carers can play an important role in these groups and I hope to take this knowledge forward in my clinical work in order to develop and evaluate such interventions.

At times, it was necessary to chase up the doctors and nurses at the various sites to remind them about the need to recruit participants. On occasion some assertiveness was required with respect to the various deadlines, following their initial agreement to help identify suitable patients. As a result, I feel that a transferable, clinical skill I have been able to develop whilst undertaking this project has been communication in the context of power dynamics between professionals. Whilst the other healthcare professionals had agreed to help, I was nevertheless an "outsider" and less senior, so pressing them to identify people from clinics and negotiate my attendance was difficult at times; but negotiated in a professional manner. Ultimately, I enjoyed collaborating with the site clinicians and hope to maintain links with them. This will no doubt be an important skill to take forward into my clinical work in teams.

4. If you were to undertake further research in this area what would that research project seek to answer and how would you go about doing it?

One of the areas of future research that this study has identified is the need for evaluation of more theory-led reminiscence or autobiographical memory-based

interventions for people with dementia to improve quality of life. If I am able to undertake related research in future, I would look to design and pilot such an intervention, based on the theoretical stance adopted and tested by this study, and research the efficacy of the intervention for improving quality of life or cognitive test scores in dementia, carer, and older adult samples. Ideally, this would take the form of a randomised controlled trial; however if randomisation was not be possible a trial with a waiting list control group might suffice. Outcome measures would include quality of life, carer quality of life, semantic and episodic autobiographical memory, psychological wellbeing and performance on selected cognitive tests (e.g. memory and attention).

Further to this, I would also be interested in exploring autobiographical memory-based rehabilitative work in samples with other neurological conditions, including stroke, cancer, autoimmune conditions affecting the brain, and traumatic brain injury. This would first require a better understanding of how autobiographical memory is affected in these populations and the relationship between other factors common to these conditions, such as depression and anxiety. A longitudinal study during recovery would enable the measurement of autobiographical memory and the effects of autobiographical memory-based intervention over time, using a within-group design and analysing the variables with repeated-measures analysis of variance. However, it would be necessary to take account of rehearsal effects of the tests, although rehearsal may be one of the beneficial techniques to improve autobiographical memory.

Future research might also explore the benefits of integrating guided generative retrieval strategies in psychotherapy for depression where a person might experience overgeneral autobiographical memory (Sumner, Griffith, & Mineka, 2010). Its structured nature might lend itself well to more structured therapy approaches such as cognitive behavioural therapy. In the absence of brain pathology, generative retrieval might be predicted to "unlock" access to more episodic representations; in combination with

techniques such as cognitive restructuring and thought challenging, generative retrieval may serve as a powerful tool for clients to reappraise past events and form new assumptions for the future.

References

Alvarez, P. & Squire, L. R. (1994). Memory consolidation and the medial temporal lobe: A simple network model. *Proceedings of the National Academy of Sciences of the United States of America, 91,* 7041-7045.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review, 107*(2), 261-288. doi:10.1037//033-295X

Department of Health. (2009). *Living Well With Dementia: A National Dementia Strategy.* London: Department of Health.

Higgins, J. P. T., & Green, S. (Eds). (2011). *Cochrane Handbook for Systematic Reviews of Interventions,* Version 5.1.0 [updated March 2011). The Cochrane Collaboration: Available from www.cochrane-handbook.org

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging, 17*(4), 677-689

McKenna, P. & Warrington, E. K. (1983). *Graded Naming Test Manual.* Windsor: NFER-Nelson.

Nadel, L., & Moscovitch, M. (1997). Memory consolidation, retrograde amnesia and the hippocampal complex. *Current Opinion in Neurobiology, 7*(2), 217-227.

Sumner, J., Griffith, J. & Mineka, S. (2010). Overgeneral autobiographical memory as a predictor of the course of depression: A meta-analysis. *Behavior Research & Therapy, 48*(7), 614-625.

Wechsler, D. (1998). *Wechsler Memory Scale Test Manual* (3rd Ed). London: The Psychological Corporation.

Maxwell James Benjamin B.Sc. (Hons)., M.Sc.

Major Research Project

Section D: Appendices

September 2013

SALOMONS

CANTERBURY CHRIST CHURCH UNIVERSITY

Appendix A

Reliability and Validity Definitions

1. Test-retest reliability

A reliable measure of AM will generate the same scores from one administration to another (assuming there is no change in other circumstances, such as deterioration in cognitive function). This is *test re-test* reliability and is usually estimated by correlating the results from both occasions, with the aim of achieving at least $r = .8$ (Clark-Carter, 2010).

2. Inter-rater reliability

Tests of AM must also generate the same score if it is administered by a different people. This is *inter-rater* reliability, and is usually estimated using Cohen's kappa, with coefficients of $\kappa = .4$-$.6$ considered fair, $\kappa = .6$-$.75$ considered good, and $\kappa = .75$ and above considered excellent (Clark-Carter, 2010). Inter-rater reliability is also estimated using Pearson's product moment coefficient (r), however this is not generally recommended as inter-rater correlations are not an indication of whether the exact same score was awarded by two separate raters (Clark-Carter, 2010).

3. Construct validity

A valid measure of AM will have *convergent* and *divergent* construct validity. That is, it will correlate with other acceptably reliable and valid AM tasks (convergent construct validity). Similarly, scales of episodic AM should arguably not correlate highly with tests of semantic memory, and vice versa (divergent construct validity) (Clark-Carter, 2010). Construct validity coefficients are usually estimated with Pearson's r.

4. Concurrent validity

Concurrent validity demonstrates that the measure produces similar results to other, acceptably reliable and valid measures of AM administered at about the same time (Clark-Carter, 2010), typically estimated with Pearson's *r*.

5. Content validity

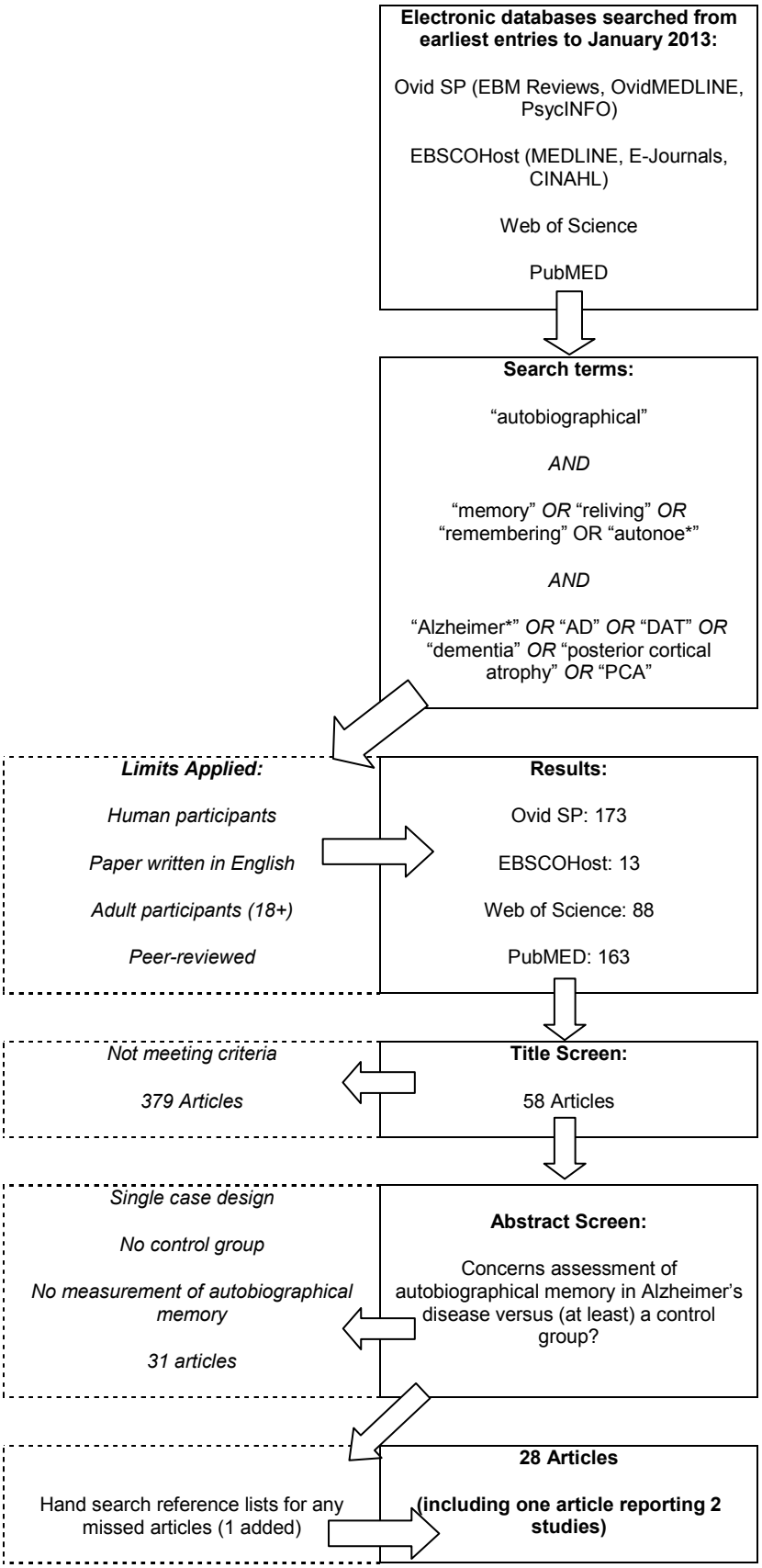
Measures should have acceptable *content validity*. That is, they should assess, as far as possible, the full range of the ability being tested (Clark-Carter, 2010). This type of validity is more of a qualitative judgement, based on the theoretical knowledge of experts in the area being studied (Clark-Carter, 2010). Thus, AM measures should facilitate generative or direct retrieval via the predicted cognitive mechanisms of executive function, WM, semantic knowledge, and ESK.

6. Internal consistency

Internal consistency refers to the extent to which a measure contains items that are similar to each other (Clark-Carter, 2010). This is considered non-applicable to tests of episodic AM as they essentially ask the same question as part of an interview across different life-periods, and are not truly distinct items. As other measures such as inter-rater reliability are more appropriate to indicate the quality of an AM measure, internal consistency is not addressed in this review.

Appendix B

Systematic Search



Appendix C

Identified Study Characteristics

Autobiographical memory (ABM) in Alzheimer's disease (AD) study characteristics.

Study (ABM Measure)	AD Group MMSE Mean or Range	MMSE SD	AD Group Size	Control Group Size	Age Matched?	Other Matching?
Severe AD						
Sartori 2004 (ABME + ABF)	11.8	3.2	10	10	Yes	Education
Addis 2004 (AMI + ABF)	19.85	3.15	20	20	Yes	Education
Mild to Moderate AD						
Leyhe 2009 (AMI)	20.3	5.9	20	20	Yes	Education
Kazui 2000 (FLT)	20.5	4.3	25	25	Yes	Education
Moses 2004 (AMT)	20.9	2.6	10	10	Yes	Education
Graham 1997 (AMI)	21.5	1.4	6	24	Yes	Education
Irish 2006 (AMI)	21.6	3.72	10	10	Yes	Education
Starkstein 2005 (AMS)	21.8	6.5	17	10	Yes	Education
El Haj 2012b (TEMPau)	21.92	1.62	12	12	Yes	Education
Dorrego 1999 (AMS)	22	5.2	25	20	No (AD<HC)	Education
Eustache 2004 (Experimental)	22.2	2.3	17	14	Yes	Education

Hou 2005 (AMI)	23.0	NR	8	8	Yes	Education
Piolino 2003 (TEMPau)	22.3	2.1	13	18	Yes	Education
Nestor 2002 Experiment A (AMI)	22.7	2.8	9	9	No (HC<AD)	Education
El Haj 2012a (TEMPau)	23.13	1.67	16	32	Yes	Education
Greene, Miles 1996 (AMI + ABF)	23.5	4.1	33	30	Yes	Education & IQ
Nestor 2002 Experiment B (Crovitz)	23.7	3.5	6	10	No (HC<AD)	Education
Barnabe 2012 (AMI + AI)	23.7	1.77	10	10	Yes	Education
Greene & Hodges 1996 (AMI + ABF)	23.9	3.0	24	30	Yes	Education & IQ
Irish, Lawlor 2011 (EAMI)	24.0	2.4	20	30 mid-aged 30 old-aged	Yes (to old-aged)	No
El Haj 2011 (TEMPau)	24.05	1.46	16	16	Yes	Education
Donix 2010 (AMT)	24.19	2.95	16	16	Yes	Education
Meeter 2006 (AMI)	24.5	NR	21	21	Yes	Education
Irish, Hornberger 2011 (AI)	24.5	3.9	17	19	Yes	Education
Meulenbroek 2010 (AI)	25.3	3.2	21	22	Yes	Education
Two AD Samples						

Greene 1995 (AMI + ABF)			33 total	30	Yes	Education
Mild AD	20.3	3.3	16			
Minimal AD	26.2	2.2	17			
Ivanoiu 2004 (AMI)			20 total	21	NR	NR
Mild AD	18-22	NR	11			
Minimal AD	23-26	NR	9			
Ivanoiu 2006 (AMI+ABF)			20 total	21	No (HC<AD)	No
Mild-Moderate AD	20.09	1.87	10			
Minimal AD	24.67	1.22	10			
Sagar 1988 (Crovitz)			19 total	20	Yes	Education
Moderate-Severe AD	BDS = 10-27	NR	10			
Mild AD	BDS = 6-9	NR	9			

NR = not reported; MMSE = Mini Mental State Examination; BDS = Blessed Dementia Scale (MMSE not used)

Appendix D

Verbal Autobiographical Fluency (VAF) Task Scoring Procedure

Scores	VAF1	VAF2	VAF3
Correct Responses	Life-periods lasting at least three years (can overlap)	General events lasting several weeks or months (can be repeated within chosen life period)	Unique, one-off events lasting less than a day from within the chosen general event.
Errors	Life-periods lasting less than three years or unique events	General events lasting for several years, or less than a day. Events not from chosen life-period	Events lasting for more than a day, or were repeated events. Events not from the specified general event.

From Piolino et al. (2010).

Appendix E

Autobiographical Interview Scoring Criteria

Category	Description
Internal events (episodic)	
Event	Happenings, individuals present, weather conditions, physical/emotional actions, or reactions in others.
Time	Year, season, month, day of the week, time of day.
Place	Localisation of an event including the city, street, building, room, part of room.
Perceptual	Auditory, olfactory, tactile, visual and visual details, body position, duration.
Thought/emotion	Emotional state, thoughts, implications
External events (semantic)	
Event	Specific details from other incidents (from all of the above categories) external to the chosen event recalled.
Semantic	General knowledge or facts, ongoing events, extended states of being.
Repetition	Unsolicited repetition of details.
Other	Metacognitive statements, editorialising.

From Levine et al. (2002)

Appendix F

Analyses to test parametric assumptions of the variables (between-groups)

DASS Anxiety

Descriptives

	Group			Statistic	Std. Error
DASS Anxiety Score	Controls	Mean		4.40	1.996
		95% Confidence Interval for Mean	Lower Bound	-.11	
			Upper Bound	8.91	
		5% Trimmed Mean		3.89	
		Median		1.00	
		Variance		39.822	
		Std. Deviation		6.310	
		Minimum		0	
		Maximum		18	
		Range		18	
		Interquartile Range		9	
		Skewness		1.416	.687
		Kurtosis		1.114	1.334
	AD	Mean		3.40	1.118
		95% Confidence Interval for Mean	Lower Bound	.87	
			Upper Bound	5.93	
		5% Trimmed Mean		3.22	
		Median		3.00	
		Variance		12.489	
		Std. Deviation		3.534	
		Minimum		0	
		Maximum		10	
		Range		10	
		Interquartile Range		6	
		Skewness		.568	.687
		Kurtosis		-.739	1.334

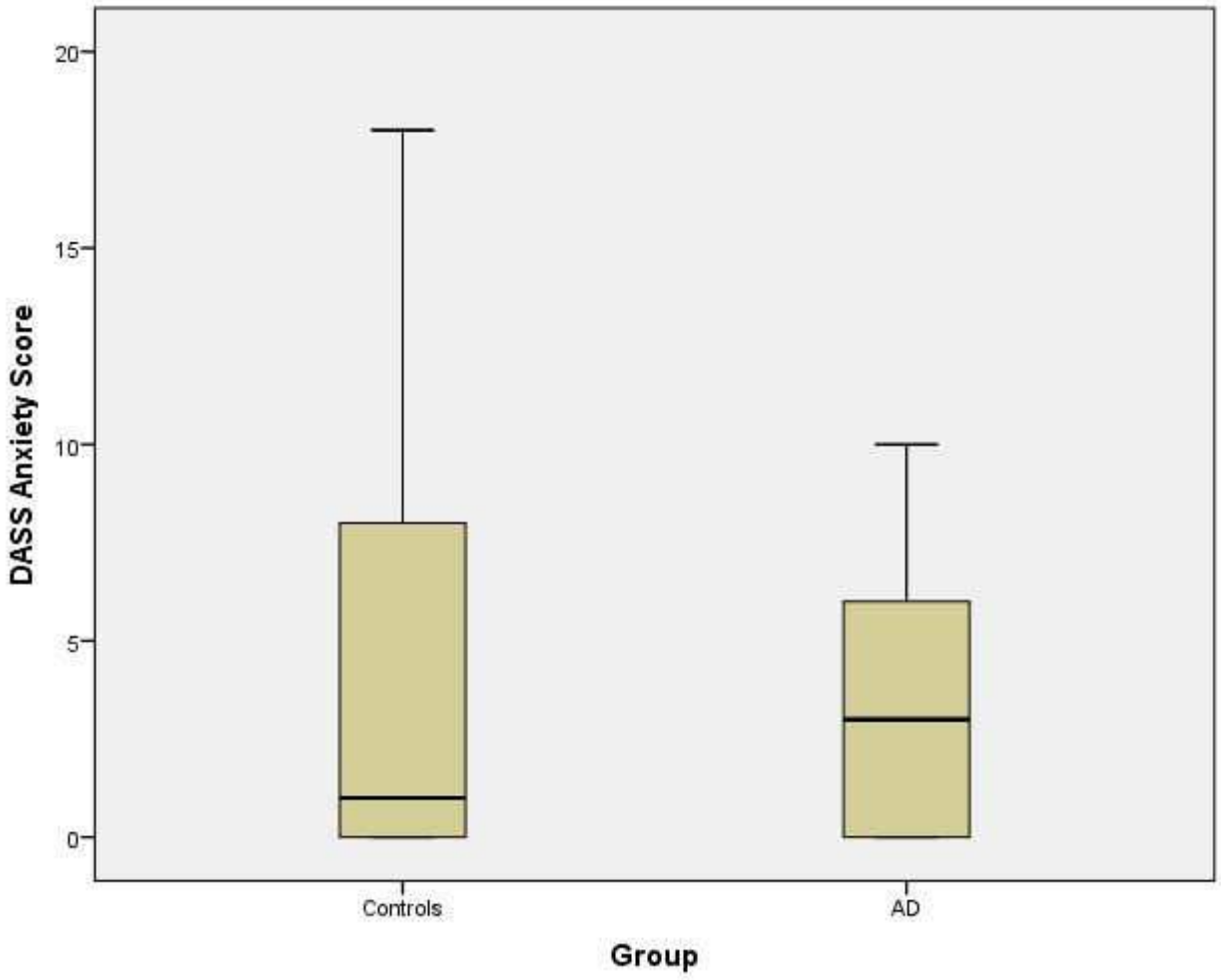
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
DASS Anxiety Score	Based on Mean	2.565	1	18	.127
	Based on Median	.580	1	18	.456
	Based on Median and with adjusted df	.580	1	10.529	.463
	Based on trimmed mean	1.830	1	18	.193

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
DASS Anxiety Score	Controls	.257	10	.060	.765	10	.005
	AD	.232	10	.136	.857	10	.070

a. Lilliefors Significance Correction



DASS Depression

Descriptives

	Group			Statistic	Std. Error
DASS Depression Score	Controls	Mean		8.80	3.144
		95% Confidence Interval for Mean	Lower Bound	1.69	
			Upper Bound	15.91	
		5% Trimmed Mean		8.11	
		Median		4.00	
		Variance		98.844	
		Std. Deviation		9.942	
		Minimum		0	
		Maximum		30	
		Range		30	
		Interquartile Range		15	
		Skewness		1.337	.687
		Kurtosis		.886	1.334
	AD	Mean		5.40	1.933
		95% Confidence Interval for Mean	Lower Bound	1.03	
			Upper Bound	9.77	
		5% Trimmed Mean		4.89	
		Median		3.00	
		Variance		37.378	
		Std. Deviation		6.114	
		Minimum		0	
		Maximum		20	
		Range		20	
		Interquartile Range		7	
		Skewness		1.697	.687
		Kurtosis		3.165	1.334

Test of Homogeneity of Variance

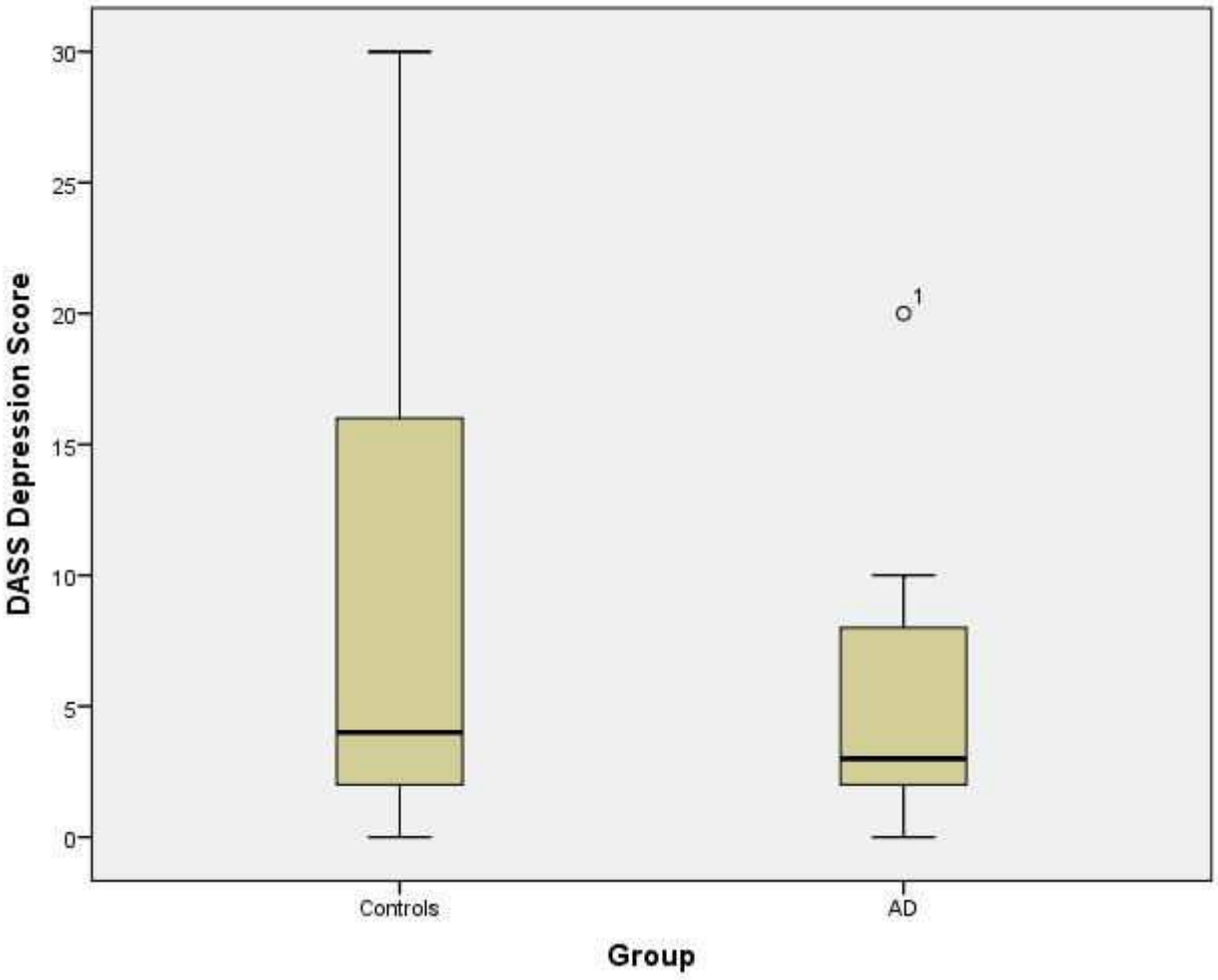
		Levene Statistic	df1	df2	Sig.
DASS Depression Score	Based on Mean	2.676	1	18	.119
	Based on Median	.695	1	18	.415
	Based on Median and with adjusted df	.695	1	14.368	.418
	Based on trimmed mean	2.100	1	18	.164

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
DASS Depression Score	Controls	.285	10	.020	.812	10	.020
	AD	.211	10	.200*	.821	10	.026

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

a. Lilliefors Significance Correction



DASS Stress

Descriptives

	Group			Statistic	Std. Error
DASS Stress Score	Controls	Mean		11.60	3.792
		95% Confidence Interval for Mean	Lower Bound	3.02	
			Upper Bound	20.18	
		5% Trimmed Mean		11.00	
		Median		8.00	
		Variance		143.822	
		Std. Deviation		11.993	
		Minimum		0	
		Maximum		34	
		Range		34	
		Interquartile Range		15	
		Skewness		1.314	.687
		Kurtosis		.500	1.334
	AD	Mean		8.60	2.386
		95% Confidence Interval for Mean	Lower Bound	3.20	
			Upper Bound	14.00	
		5% Trimmed Mean		8.22	
		Median		7.00	
		Variance		56.933	
		Std. Deviation		7.545	
		Minimum		0	
		Maximum		24	
		Range		24	
		Interquartile Range		9	
		Skewness		.997	.687
		Kurtosis		.747	1.334

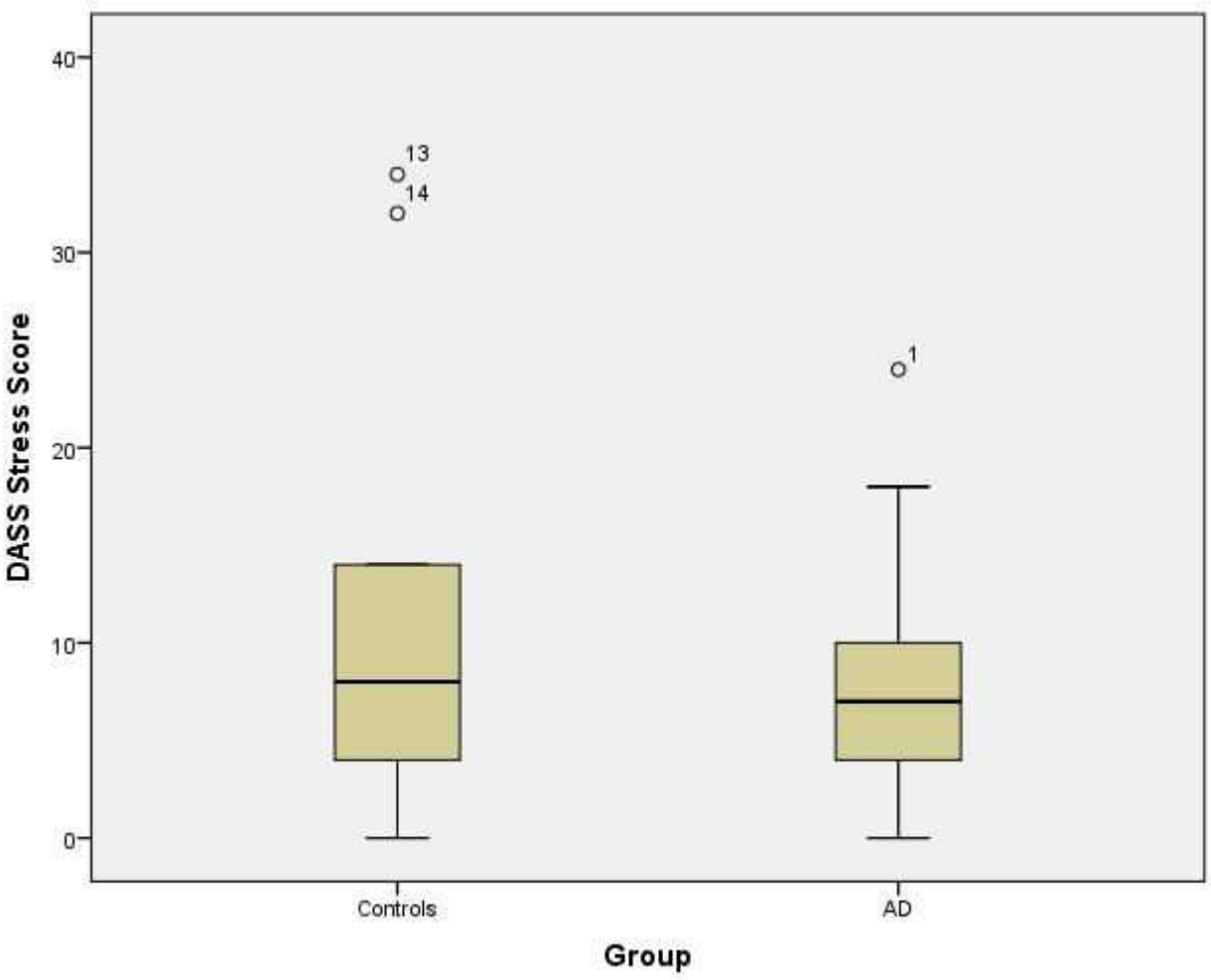
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
DASS Stress Score	Based on Mean	1.628	1	18	.218
	Based on Median	.590	1	18	.452
	Based on Median and with adjusted df	.590	1	14.149	.455
	Based on trimmed mean	1.368	1	18	.257

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
DASS Stress Score	Controls	.253	10	.069	.804	10	.016
	AD	.226	10	.157	.906	10	.256

a. Lilliefors Significance Correction



VAF 1

Descriptives

	Group			Statistic	Std. Error
VAF1 Total Lifetime Periods	Controls	Mean		8.80	.827
		95% Confidence Interval for Mean	Lower Bound	6.93	
			Upper Bound	10.67	
		5% Trimmed Mean		8.78	
		Median		8.50	
		Variance		6.844	
		Std. Deviation		2.616	
		Minimum		5	
		Maximum		13	
		Range		8	
		Interquartile Range		4	
		Skewness		.598	.687
		Kurtosis		-.310	1.334
	AD	Mean		6.60	.763
		95% Confidence Interval for Mean	Lower Bound	4.87	
			Upper Bound	8.33	
		5% Trimmed Mean		6.50	
		Median		6.00	
		Variance		5.822	
		Std. Deviation		2.413	
		Minimum		4	
		Maximum		11	
		Range		7	
		Interquartile Range		4	
		Skewness		.826	.687
		Kurtosis		-.366	1.334

Test of Homogeneity of Variance

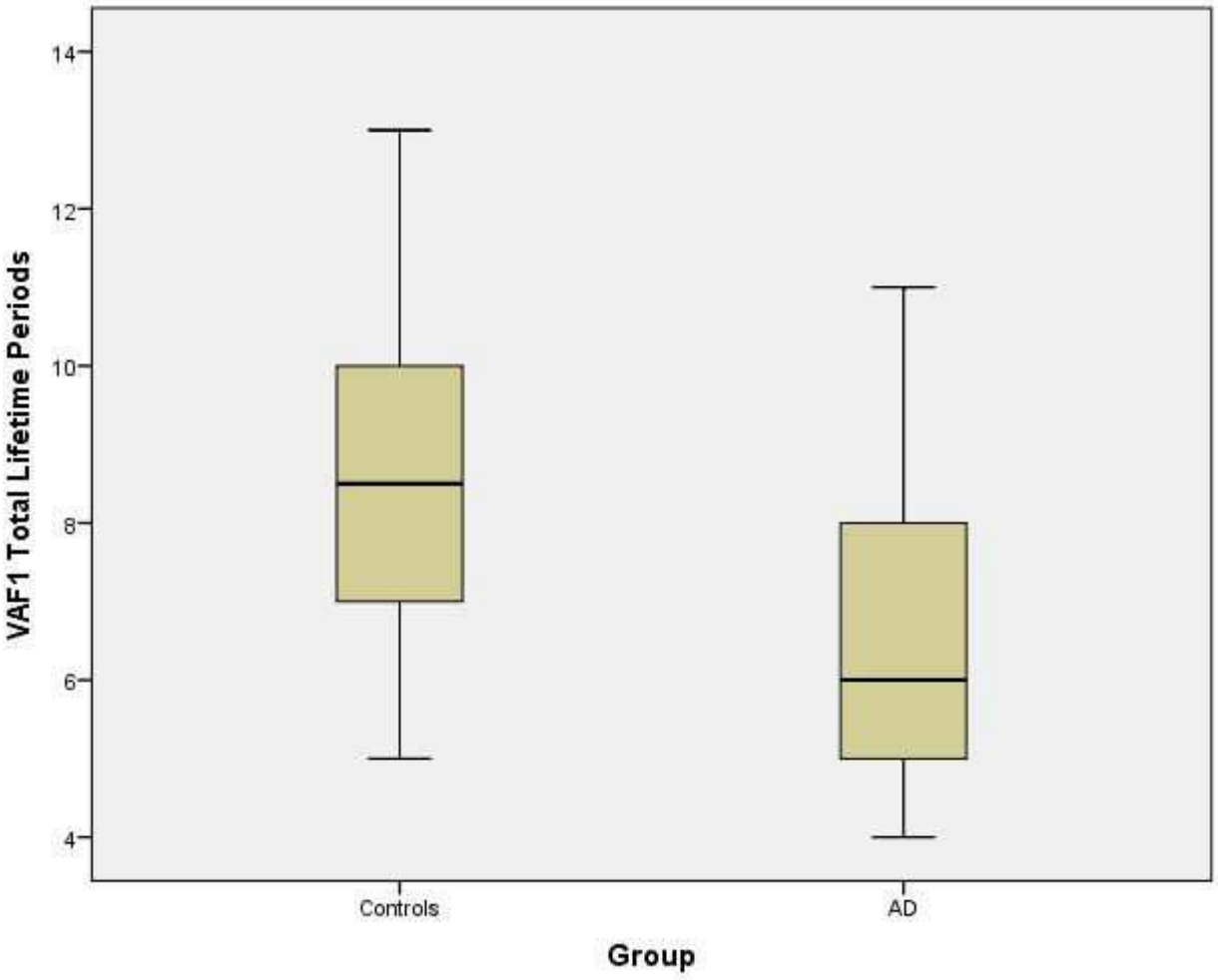
		Levene Statistic	df1	df2	Sig.
VAF1 Total Lifetime Periods	Based on Mean	.016	1	18	.902
	Based on Median	.078	1	18	.783
	Based on Median and with adjusted df	.078	1	17.990	.783
	Based on trimmed mean	.024	1	18	.879

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
VAF1 Total Lifetime Periods	Controls	.170	10	.200*	.911	10	.290
	AD	.198	10	.200*	.903	10	.236

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

a. Lilliefors Significance Correction



VAF 2

Descriptives

	Group			Statistic	Std. Error
VAF2 Total Events	Controls	Mean		6.10	.706
		95% Confidence Interval for Mean	Lower Bound	4.50	
			Upper Bound	7.70	
		5% Trimmed Mean		6.11	
		Median		5.50	
		Variance		4.989	
		Std. Deviation		2.234	
		Minimum		3	
		Maximum		9	
		Range		6	
		Interquartile Range		4	
		Skewness		.144	.687
		Kurtosis		-1.694	1.334
	AD	Mean		4.20	.727
		95% Confidence Interval for Mean	Lower Bound	2.55	
			Upper Bound	5.85	
		5% Trimmed Mean		4.11	
		Median		4.00	
		Variance		5.289	
		Std. Deviation		2.300	
		Minimum		1	
		Maximum		9	
		Range		8	
		Interquartile Range		3	
		Skewness		.861	.687
		Kurtosis		1.000	1.334

Test of Homogeneity of Variance

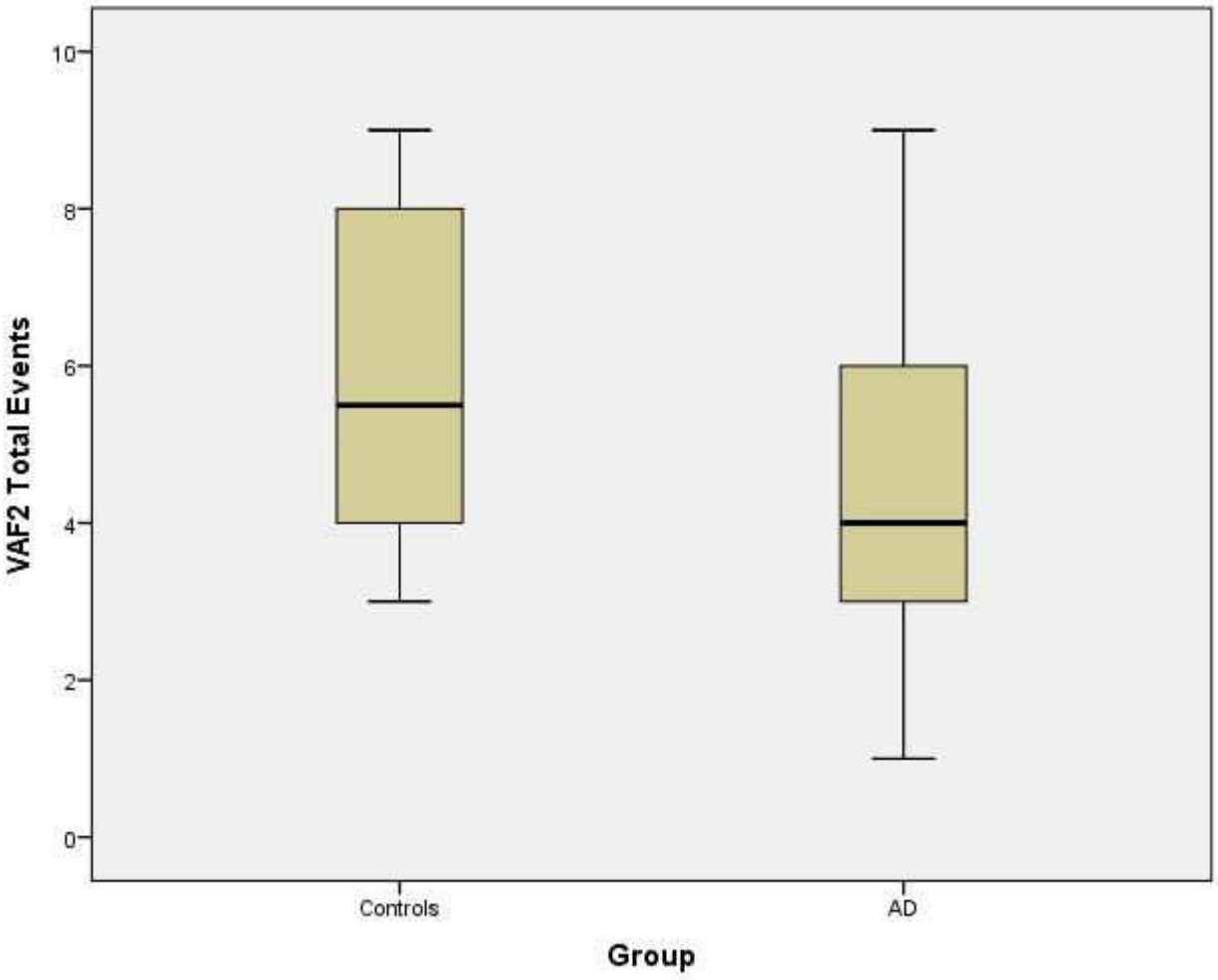
		Levene Statistic	df1	df2	Sig.
VAF2 Total Events	Based on Mean	.189	1	18	.669
	Based on Median	.233	1	18	.635
	Based on Median and with adjusted df	.233	1	16.627	.636
	Based on trimmed mean	.243	1	18	.628

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
VAF2 Total Events	Controls	.203	10	.200*	.899	10	.213
	AD	.235	10	.126	.935	10	.499

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

a. Lilliefors Significance Correction



VAF 3

Descriptives

	Group			Statistic	Std. Error
VAF3 Total Events (<24 hours)	Controls	Mean		4.60	.499
		95% Confidence Interval for Mean	Lower Bound	3.47	
			Upper Bound	5.73	
		5% Trimmed Mean		4.50	
		Median		4.00	
		Variance		2.489	
		Std. Deviation		1.578	
		Minimum		3	
		Maximum		8	
		Range		5	
		Interquartile Range		1	
		Skewness		1.681	.687
		Kurtosis		1.801	1.334
	AD	Mean		2.90	.936
		95% Confidence Interval for Mean	Lower Bound	.78	
			Upper Bound	5.02	
		5% Trimmed Mean		2.72	
		Median		1.50	
		Variance		8.767	
		Std. Deviation		2.961	
		Minimum		0	
		Maximum		9	
		Range		9	
		Interquartile Range		4	
		Skewness		1.309	.687
		Kurtosis		.750	1.334

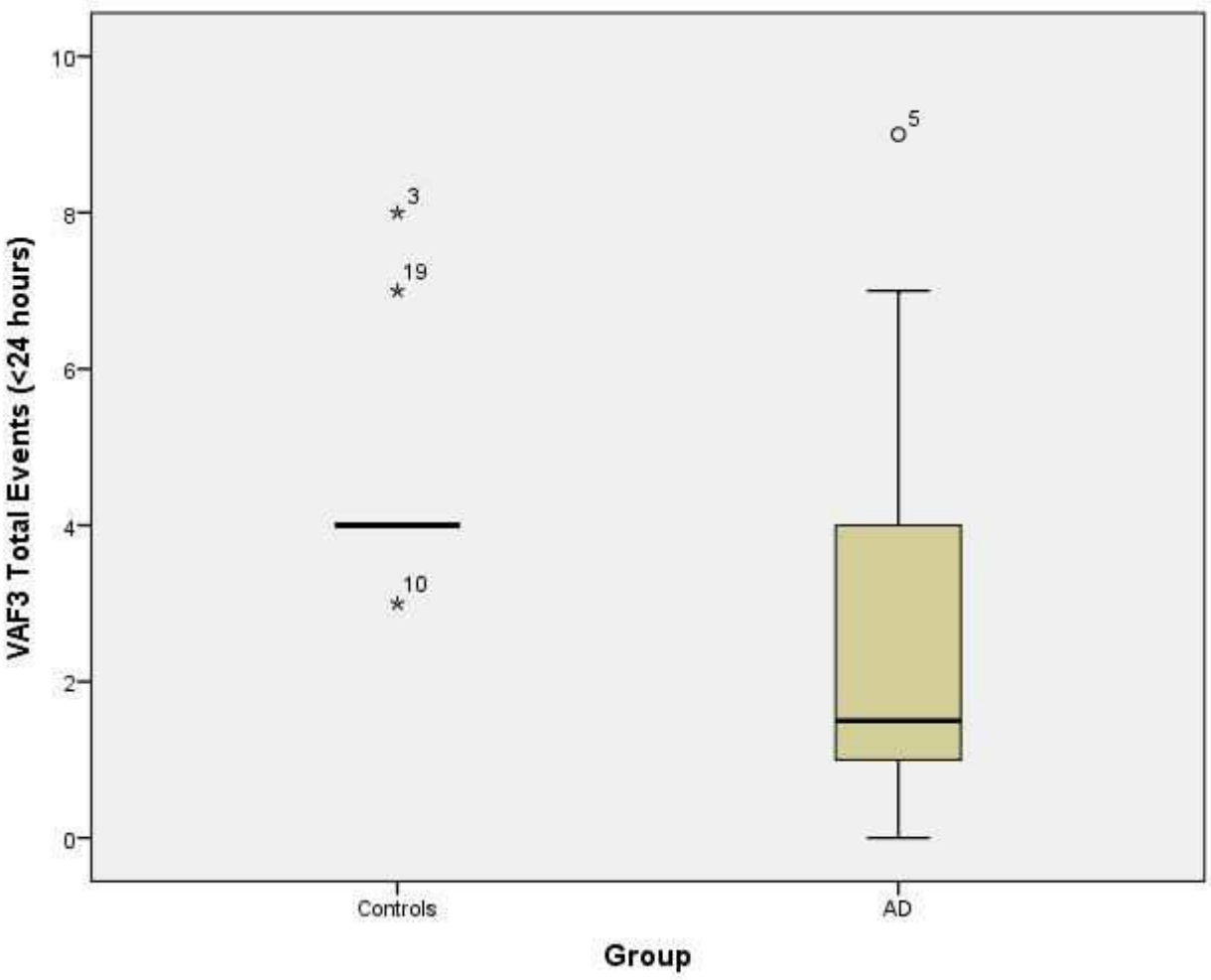
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
VAF3 Total Events (<24 hours)	Based on Mean	3.148	1	18	.093
	Based on Median	2.055	1	18	.169
	Based on Median and with adjusted df	2.055	1	14.740	.173
	Based on trimmed mean	3.004	1	18	.100

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
VAF3 Total Events (<24 hours)	Controls	.448	10	.000	.664	10	.000
	AD	.239	10	.109	.825	10	.029

a. Lilliefors Significance Correction



VAF 4 Episodic AM (Percentage)

Descriptives

	Group			Statistic	Std. Error
AI: Percentage Internal Details as a function of Total reponses	Controls	Mean		54.9200	5.57974
		95% Confidence Interval for Mean	Lower Bound	42.2978	
			Upper Bound	67.5422	
		5% Trimmed Mean		55.0111	
		Median		60.6100	
		Variance		311.335	
		Std. Deviation		17.64469	
		Minimum		29.63	
		Maximum		78.57	
		Range		48.94	
		Interquartile Range		29.36	
		Skewness		-.289	.687
		Kurtosis		-1.574	1.334
	AD	Mean		34.5060	8.73740
		95% Confidence Interval for Mean	Lower Bound	14.7406	
			Upper Bound	54.2714	
		5% Trimmed Mean		33.7106	
		Median		30.3000	
		Variance		763.422	
		Std. Deviation		27.63010	
		Minimum		.00	
		Maximum		83.33	
		Range		83.33	
		Interquartile Range		50.32	
		Skewness		.397	.687
		Kurtosis		-.943	1.334

Test of Homogeneity of Variance

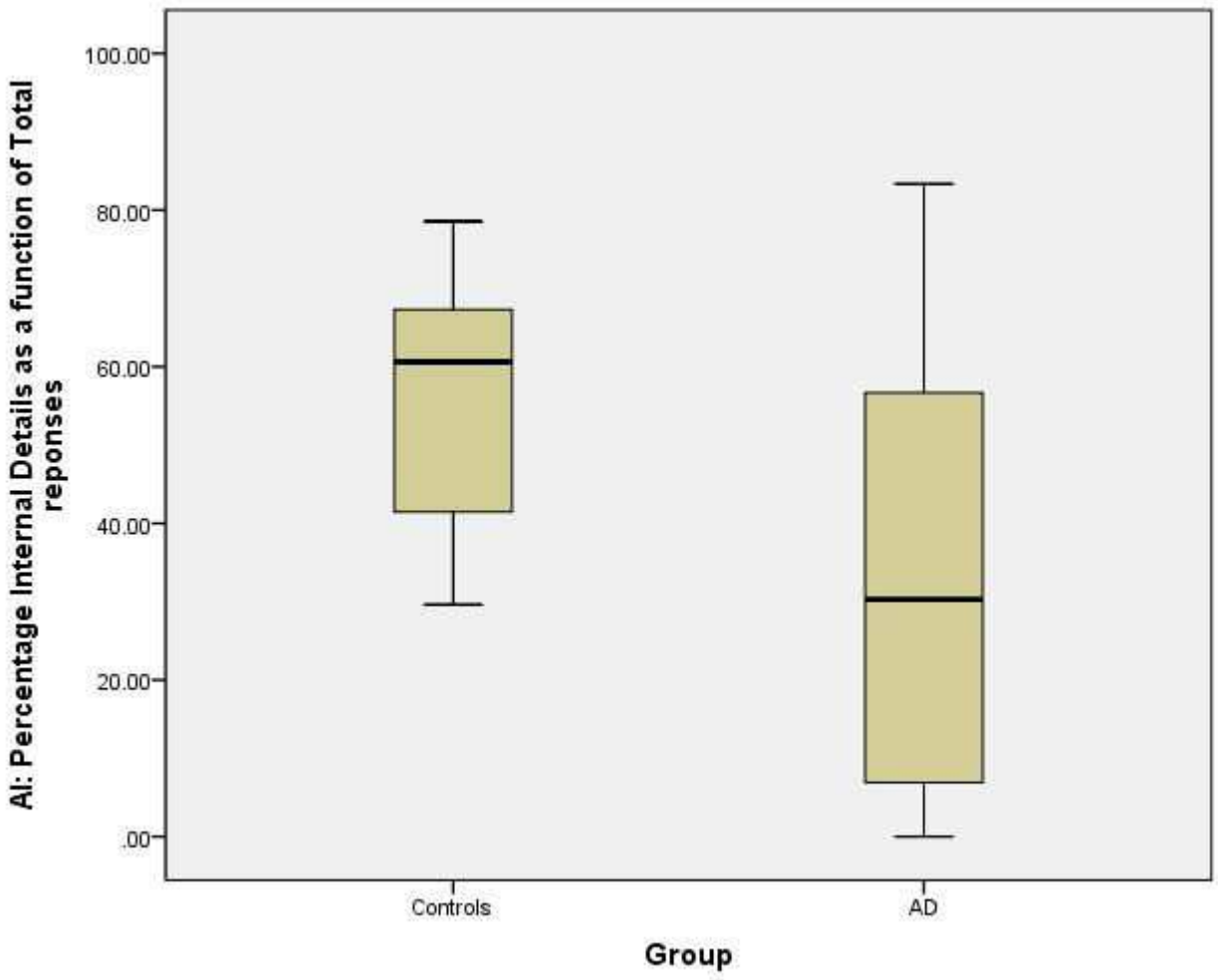
		Levene Statistic	df1	df2	Sig.
AI: Percentage Internal Details as a function of Total reponses	Based on Mean	2.520	1	18	.130
	Based on Median	1.844	1	18	.191
	Based on Median and with adjusted df	1.844	1	15.563	.194
	Based on trimmed mean	2.331	1	18	.144

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
AI: Percentage Internal Details as a function of Total reponses	Controls	.247	10	.084	.902	10	.229
	AD	.158	10	.200*	.935	10	.501

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

a. Lilliefors Significance Correction



WTAR FSIQ

Descriptives

	Group			Statistic	Std. Error
WTAR Predicted Full Scale IQ	Controls	Mean		100.40	2.941
		95% Confidence Interval for Mean	Lower Bound	93.75	
			Upper Bound	107.05	
		5% Trimmed Mean		100.50	
		Median		99.50	
		Variance		86.489	
		Std. Deviation		9.300	
		Minimum		85	
		Maximum		114	
		Range		29	
		Interquartile Range		14	
		Skewness		.084	.687
		Kurtosis		-.300	1.334
	AD	Mean		97.70	2.539
		95% Confidence Interval for Mean	Lower Bound	91.96	
			Upper Bound	103.44	
		5% Trimmed Mean		97.67	
		Median		99.00	
		Variance		64.456	
		Std. Deviation		8.028	
		Minimum		87	
		Maximum		109	
		Range		22	
		Interquartile Range		15	
		Skewness		-.118	.687
		Kurtosis		-1.526	1.334

Test of Homogeneity of Variance

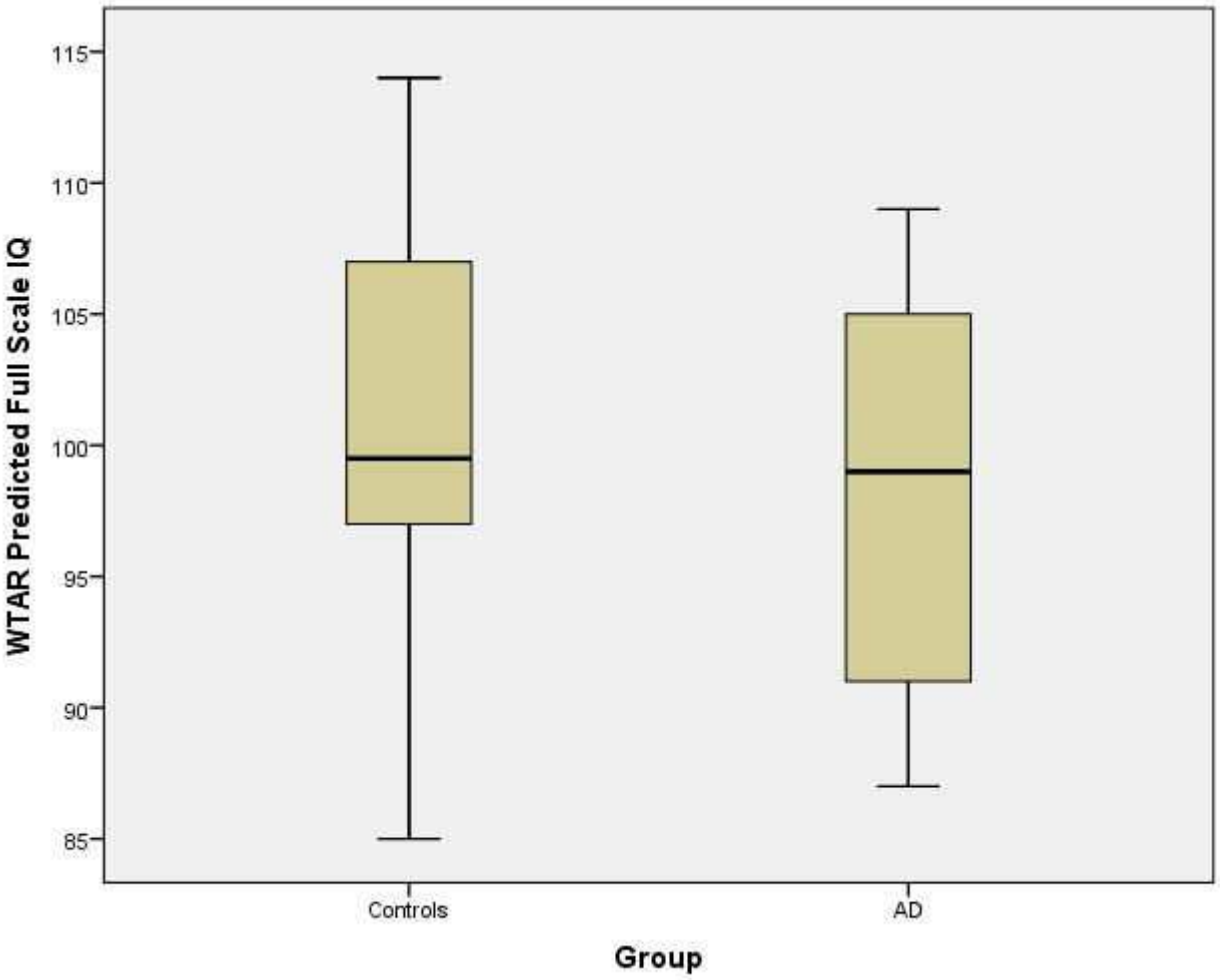
		Levene Statistic	df1	df2	Sig.
WTAR Predicted Full Scale IQ	Based on Mean	.000	1	18	1.000
	Based on Median	.002	1	18	.967
	Based on Median and with adjusted df	.002	1	15.448	.967
	Based on trimmed mean	.000	1	18	.988

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
WTAR Predicted Full Scale IQ	Controls	.217	10	.199	.934	10	.487
	AD	.161	10	.200*	.926	10	.413

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

a. Lilliefors Significance Correction



Age (Years)

Descriptives

	Group			Statistic	Std. Error
Age in Years	Controls	Mean		61.40	3.718
		95% Confidence Interval for Mean	Lower Bound	52.99	
			Upper Bound	69.81	
		5% Trimmed Mean		61.33	
		Median		62.00	
		Variance		138.267	
		Std. Deviation		11.759	
		Minimum		42	
		Maximum		82	
		Range		40	
		Interquartile Range		17	
		Skewness		.087	.687
		Kurtosis		-.106	1.334
	AD	Mean		66.20	3.511
		95% Confidence Interval for Mean	Lower Bound	58.26	
			Upper Bound	74.14	
		5% Trimmed Mean		65.89	
		Median		63.50	
		Variance		123.289	
		Std. Deviation		11.104	
		Minimum		52	
		Maximum		86	
		Range		34	
		Interquartile Range		17	
		Skewness		.704	.687
		Kurtosis		-.338	1.334

Test of Homogeneity of Variance

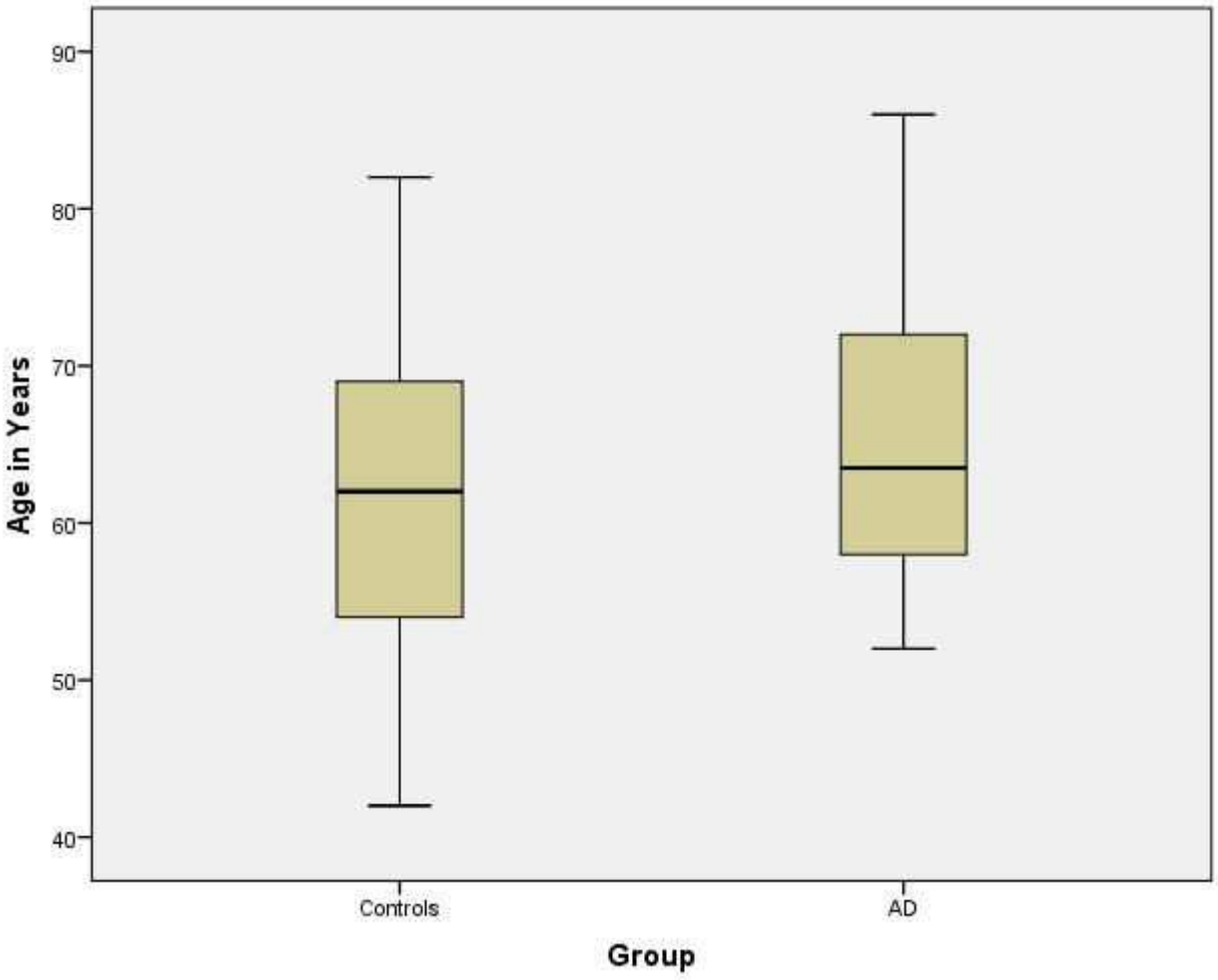
		Levene Statistic	df1	df2	Sig.
Age in Years	Based on Mean	.009	1	18	.927
	Based on Median	.015	1	18	.903
	Based on Median and with adjusted df	.015	1	18.000	.903
	Based on trimmed mean	.014	1	18	.908

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Age in Years	Controls	.120	10	.200*	.994	10	.999
	AD	.147	10	.200*	.937	10	.521

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

a. Lilliefors Significance Correction



Years Education

Descriptives

	Group			Statistic	Std. Error
Years in Education	Controls	Mean		11.80	1.181
		95% Confidence Interval for Mean	Lower Bound	9.13	
			Upper Bound	14.47	
		5% Trimmed Mean		11.56	
		Median		10.50	
		Variance		13.956	
		Std. Deviation		3.736	
		Minimum		7	
		Maximum		21	
		Range		14	
		Interquartile Range		3	
		Skewness		1.730	.687
		Kurtosis		4.338	1.334
	AD	Mean		11.90	.752
		95% Confidence Interval for Mean	Lower Bound	10.20	
			Upper Bound	13.60	
		5% Trimmed Mean		11.78	
		Median		11.00	
		Variance		5.656	
		Std. Deviation		2.378	
		Minimum		10	
		Maximum		16	
		Range		6	
		Interquartile Range		4	
		Skewness		1.139	.687
		Kurtosis		-.108	1.334

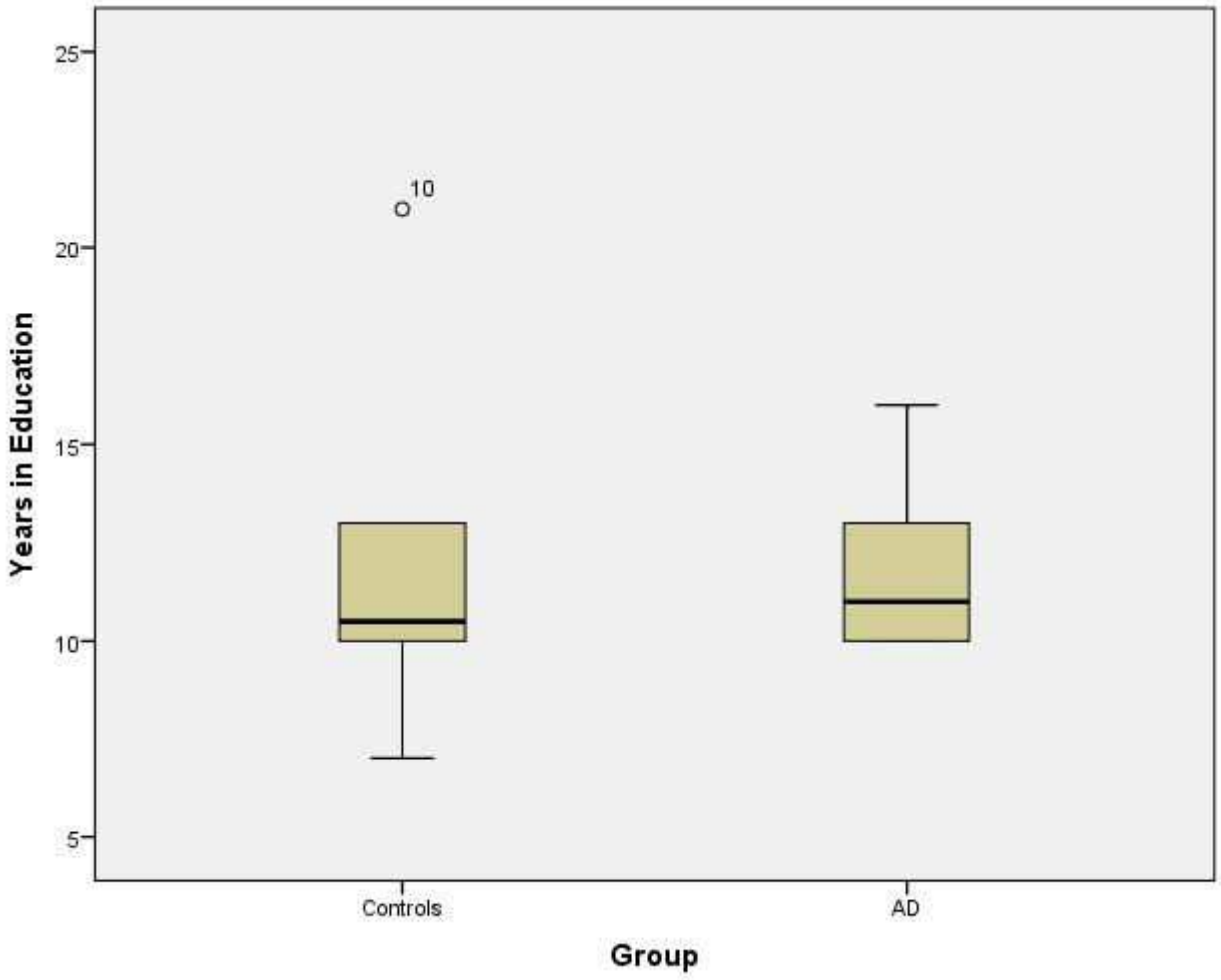
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Years in Education	Based on Mean	.550	1	18	.468
	Based on Median	.383	1	18	.544
	Based on Median and with adjusted df	.383	1	14.669	.545
	Based on trimmed mean	.485	1	18	.495

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
Years in Education	Controls	.274	10	.032	.807	10	.018
	AD	.247	10	.083	.781	10	.008

a. Lilliefors Significance Correction



ACE-R Total (/100)

Descriptives

	Group			Statistic	Std. Error
ACE-R Total Score /100	Controls	Mean		92.00	2.704
		95% Confidence Interval for Mean	Lower Bound	85.88	
			Upper Bound	98.12	
		5% Trimmed Mean		92.89	
		Median		94.50	
		Variance		73.111	
		Std. Deviation		8.551	
		Minimum		69	
		Maximum		99	
		Range		30	
		Interquartile Range		5	
		Skewness		-2.569	.687
		Kurtosis		7.239	1.334
	AD	Mean		63.00	3.166
		95% Confidence Interval for Mean	Lower Bound	55.84	
			Upper Bound	70.16	
		5% Trimmed Mean		63.06	
		Median		65.00	
		Variance		100.222	
		Std. Deviation		10.011	
		Minimum		48	
		Maximum		77	
		Range		29	
		Interquartile Range		16	
		Skewness		-.382	.687
		Kurtosis		-.963	1.334

Test of Homogeneity of Variance

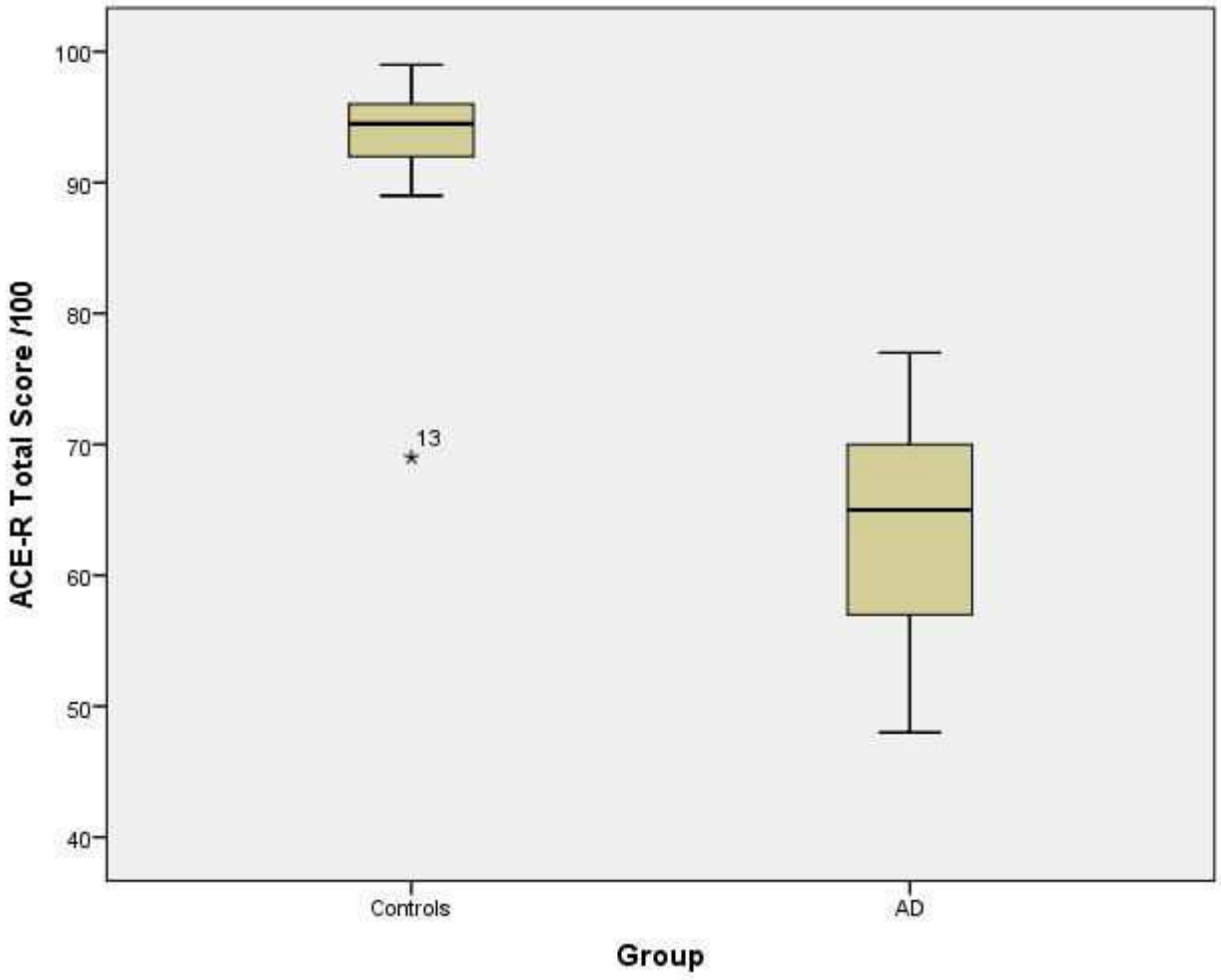
		Levene Statistic	df1	df2	Sig.
ACE-R Total Score /100	Based on Mean	1.312	1	18	.267
	Based on Median	1.283	1	18	.272
	Based on Median and with adjusted df	1.283	1	16.900	.273
	Based on trimmed mean	1.519	1	18	.234

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
ACE-R Total Score /100	Controls	.300	10	.011	.677	10	.000
	AD	.140	10	.200*	.937	10	.525

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

a. Lilliefors Significance Correction



ACE-R Fluency (/14)

Descriptives

	Group			Statistic	Std. Error
ACE-R Fluency Score /14	Controls	Mean		11.50	.637
		95% Confidence Interval for Mean	Lower Bound	10.06	
			Upper Bound	12.94	
		5% Trimmed Mean		11.61	
		Median		11.00	
		Variance		4.056	
		Std. Deviation		2.014	
		Minimum		7	
		Maximum		14	
		Range		7	
		Interquartile Range		2	
		Skewness		-.969	.687
		Kurtosis		2.211	1.334
	AD	Mean		7.60	.653
		95% Confidence Interval for Mean	Lower Bound	6.12	
			Upper Bound	9.08	
		5% Trimmed Mean		7.67	
		Median		7.00	
		Variance		4.267	
		Std. Deviation		2.066	
		Minimum		4	
		Maximum		10	
		Range		6	
		Interquartile Range		4	
		Skewness		-.178	.687
		Kurtosis		-.924	1.334

Test of Homogeneity of Variance

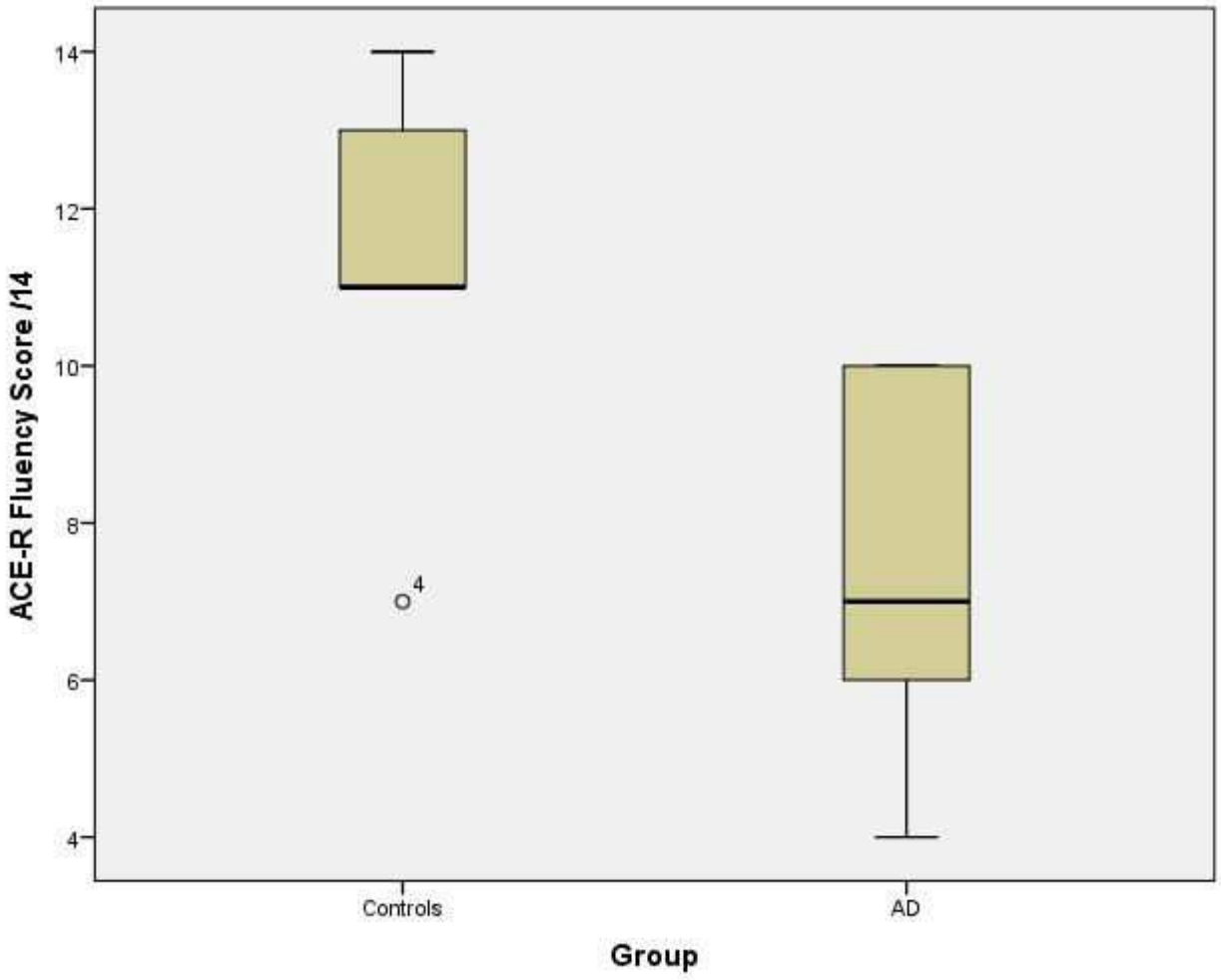
		Levene Statistic	df1	df2	Sig.
ACE-R Fluency Score /14	Based on Mean	.358	1	18	.557
	Based on Median	.210	1	18	.652
	Based on Median and with adjusted df	.210	1	17.614	.652
	Based on trimmed mean	.351	1	18	.561

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
ACE-R Fluency Score /14	Controls	.302	10	.010	.845	10	.051
	AD	.214	10	.200*	.895	10	.191

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

a. Lilliefors Significance Correction



GNT (Percentile)

Descriptives

	Group			Statistic	Std. Error
Graded Naming Test Percentile Score	Controls	Mean		69.0111	10.14630
		95% Confidence Interval for Mean	Lower Bound	45.6137	
			Upper Bound	92.4085	
		5% Trimmed Mean		71.1735	
		Median		66.0000	
		Variance		926.526	
		Std. Deviation		30.43889	
		Minimum		.10	
		Maximum		99.00	
		Range		98.90	
		Interquartile Range		35.00	
		Skewness		-1.528	.717
		Kurtosis		3.025	1.400
	AD	Mean		32.4100	9.37012
		95% Confidence Interval for Mean	Lower Bound	11.2133	
			Upper Bound	53.6067	
		5% Trimmed Mean		31.4500	
		Median		24.5000	
		Variance		877.992	
		Std. Deviation		29.63093	
		Minimum		.10	
		Maximum		82.00	
		Range		81.90	
		Interquartile Range		46.75	
		Skewness		.934	.687
		Kurtosis		-.343	1.334

Test of Homogeneity of Variance

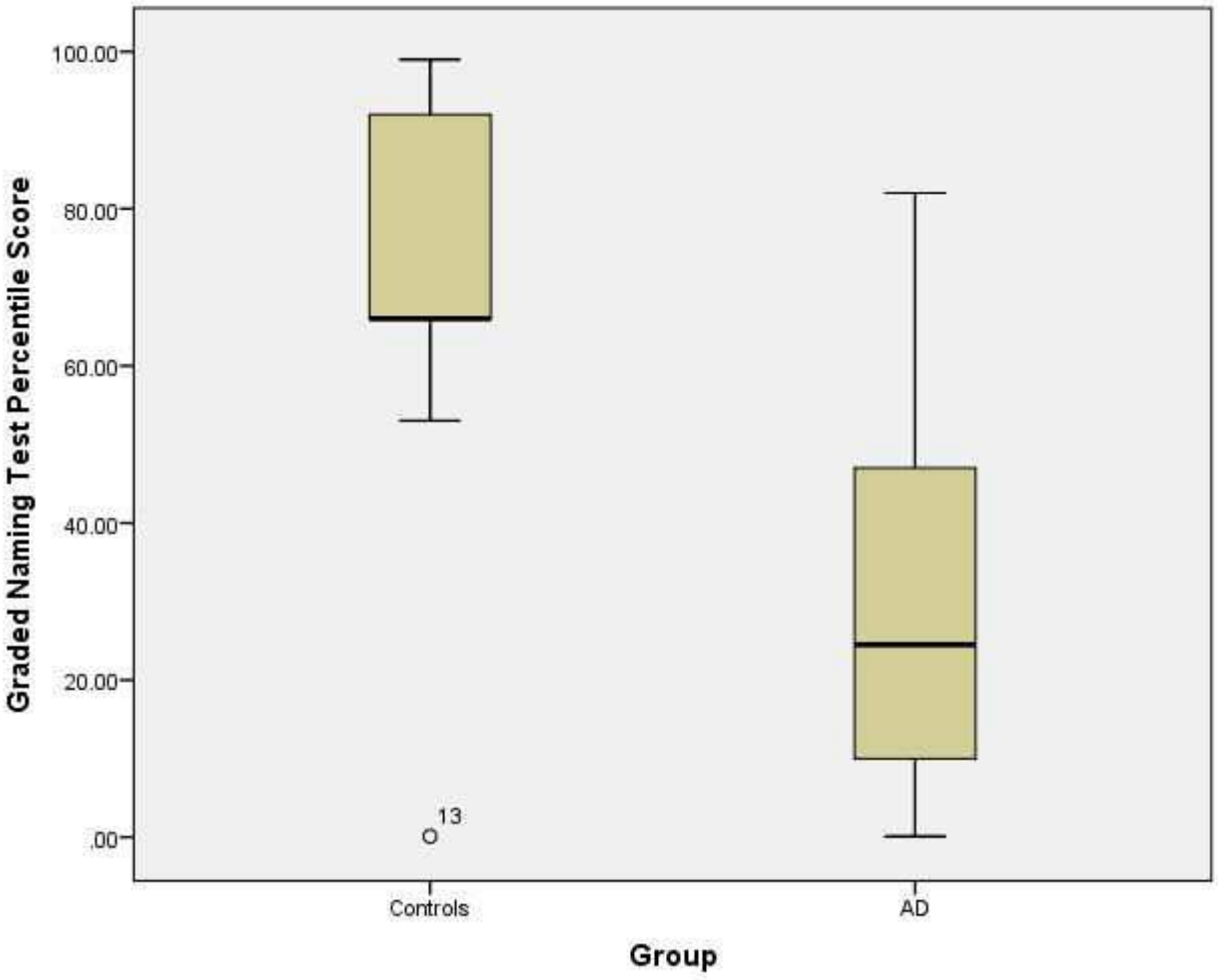
		Levene Statistic	df1	df2	Sig.
Graded Naming Test Percentile Score	Based on Mean	.064	1	17	.804
	Based on Median	.047	1	17	.830
	Based on Median and with adjusted df	.047	1	16.842	.830
	Based on trimmed mean	.041	1	17	.842

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Graded Naming Test Percentile Score	Controls	.238	9	.149	.845	9	.066
	AD	.179	10	.200*	.868	10	.095

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

a. Lilliefors Significance Correction



Spatial Span Scaled Score

Descriptives

	Group			Statistic	Std. Error
Spatial Span Scaled Score	Controls	Mean		11.56	1.156
		95% Confidence Interval for Mean	Lower Bound	8.89	
			Upper Bound	14.22	
		5% Trimmed Mean		11.51	
		Median		13.00	
		Variance		12.028	
		Std. Deviation		3.468	
		Minimum		7	
		Maximum		17	
		Range		10	
		Interquartile Range		6	
		Skewness		-.188	.717
		Kurtosis		-.963	1.400
	AD	Mean		3.50	.982
		95% Confidence Interval for Mean	Lower Bound	1.18	
			Upper Bound	5.82	
		5% Trimmed Mean		3.28	
		Median		3.00	
		Variance		7.714	
		Std. Deviation		2.777	
		Minimum		1	
		Maximum		10	
		Range		9	
		Interquartile Range		2	
		Skewness		2.240	.752
		Kurtosis		5.669	1.481

Test of Homogeneity of Variance

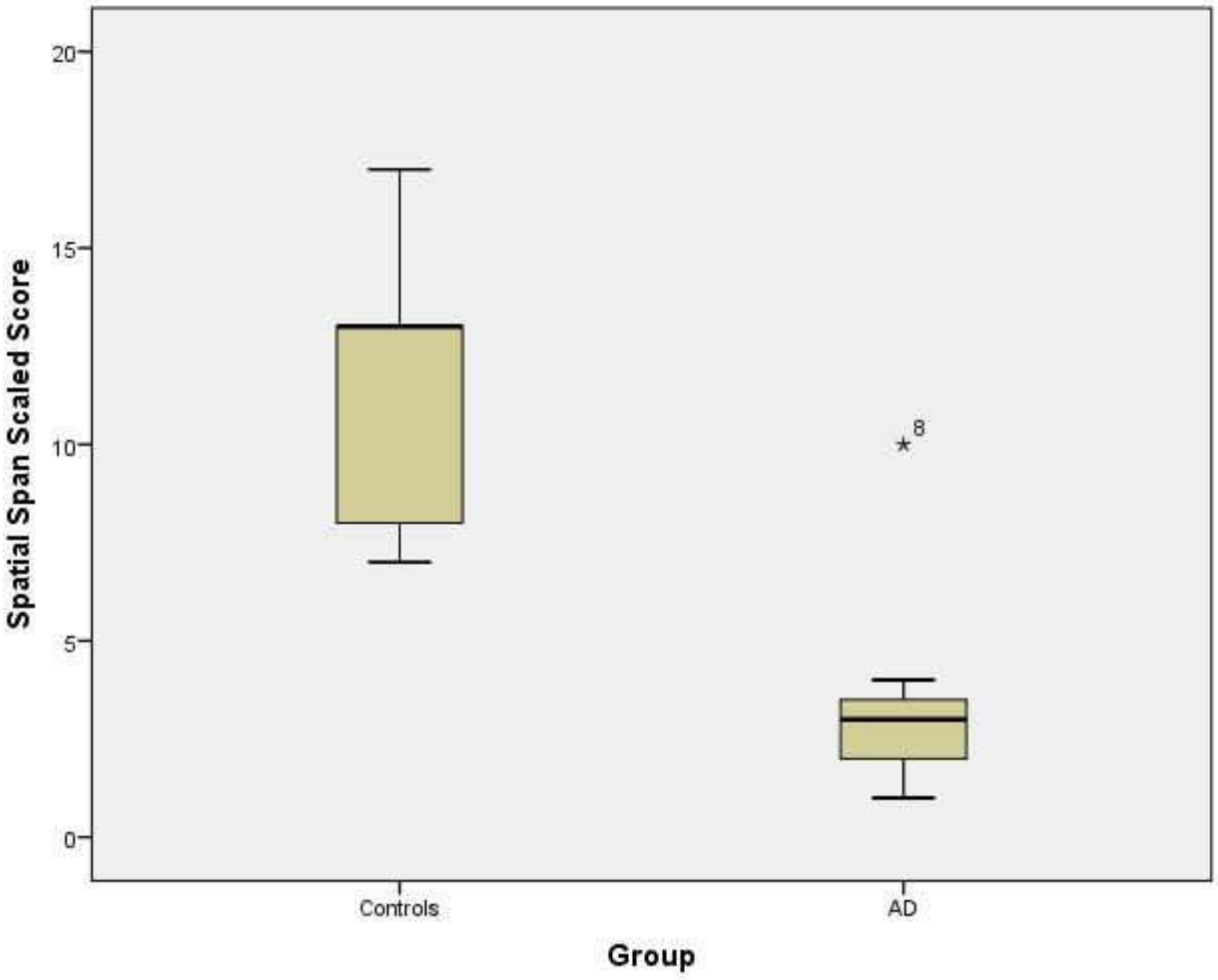
		Levene Statistic	df1	df2	Sig.
Spatial Span Scaled Score	Based on Mean	1.324	1	15	.268
	Based on Median	.751	1	15	.400
	Based on Median and with adjusted df	.751	1	14.762	.400
	Based on trimmed mean	1.584	1	15	.227

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
Spatial Span Scaled Score	Controls	.218	9	.200*	.888	9	.189
	AD	.321	8	.015	.724	8	.004

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

a. Lilliefors Significance Correction



Forwards Spatial-Span (SSF)

Descriptives

	Group			Statistic	Std. Error
WMS Spatial Span Forwards scaled score	Controls	Mean		10.67	1.202
		95% Confidence Interval for Mean	Lower Bound	7.90	
			Upper Bound	13.44	
		5% Trimmed Mean		10.69	
		Median		12.00	
		Variance		13.000	
		Std. Deviation		3.606	
		Minimum		5	
		Maximum		16	
		Range		11	
		Interquartile Range		6	
		Skewness		-.167	.717
		Kurtosis		-1.023	1.400
	AD	Mean		4.33	1.080
		95% Confidence Interval for Mean	Lower Bound	1.84	
			Upper Bound	6.82	
		5% Trimmed Mean		4.15	
		Median		3.00	
		Variance		10.500	
		Std. Deviation		3.240	
		Minimum		1	
		Maximum		11	
		Range		10	
		Interquartile Range		5	
		Skewness		1.316	.717
		Kurtosis		1.127	1.400

Test of Homogeneity of Variance

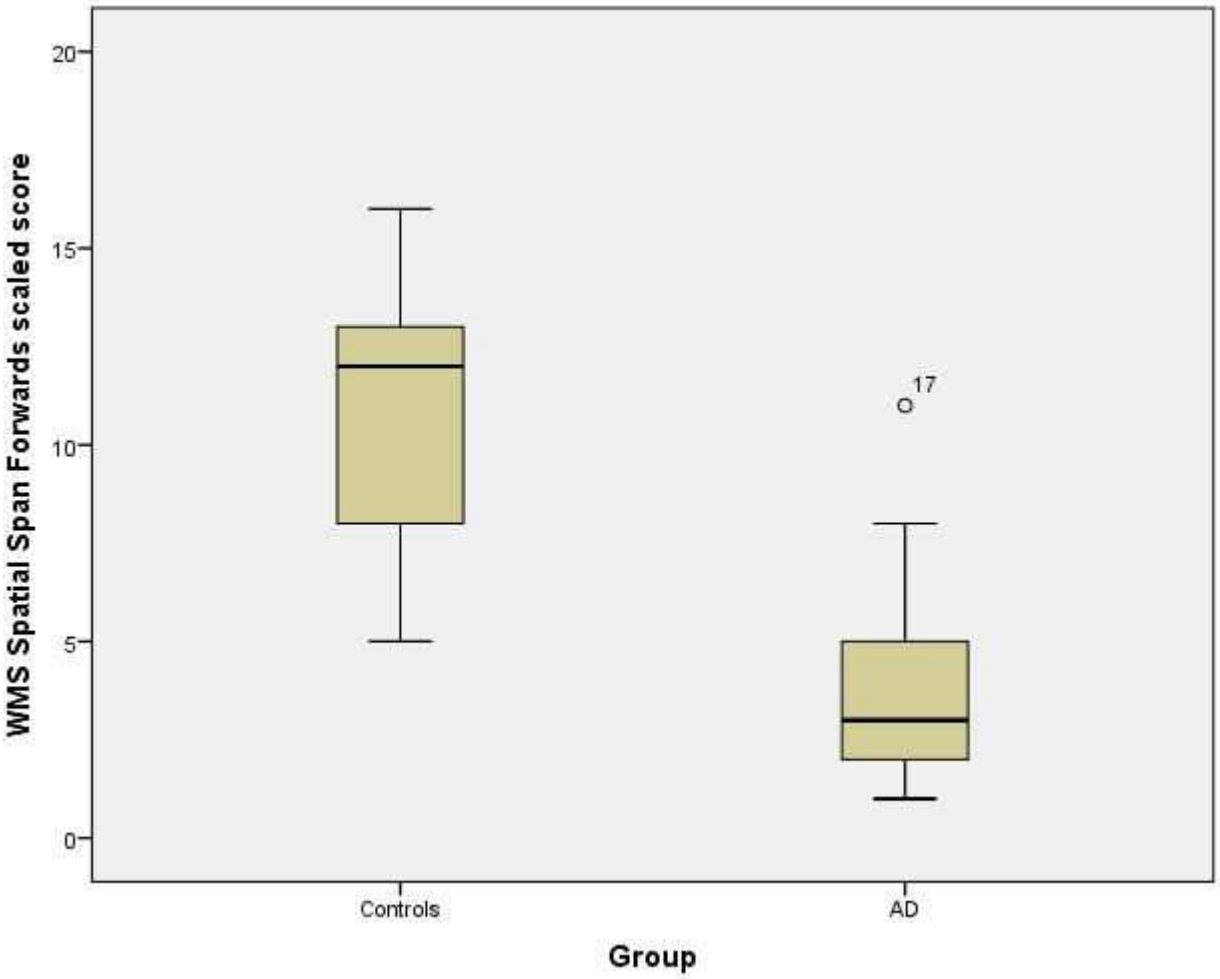
		Levene Statistic	df1	df2	Sig.
WMS Spatial Span Forwards scaled score	Based on Mean	.494	1	16	.492
	Based on Median	.319	1	16	.580
	Based on Median and with adjusted df	.319	1	15.822	.580
	Based on trimmed mean	.564	1	16	.464

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
WMS Spatial Span Forwards scaled score	Controls	.200	9	.200*	.966	9	.855
	AD	.215	9	.200*	.865	9	.107

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

a. Lilliefors Significance Correction



Backwards Spatial-Span (SSB)

Descriptives

	Group			Statistic	Std. Error
WMS Spatial Span Backwards scaled score	Controls	Mean		12.67	.943
		95% Confidence Interval for Mean	Lower Bound	10.49	
			Upper Bound	14.84	
		5% Trimmed Mean		12.74	
		Median		13.00	
		Variance		8.000	
		Std. Deviation		2.828	
		Minimum		8	
		Maximum		16	
		Range		8	
		Interquartile Range		5	
		Skewness		-.459	.717
		Kurtosis		-1.273	1.400
	AD	Mean		3.56	.988
		95% Confidence Interval for Mean	Lower Bound	1.28	
			Upper Bound	5.83	
		5% Trimmed Mean		3.34	
		Median		2.00	
		Variance		8.778	
		Std. Deviation		2.963	
		Minimum		1	
		Maximum		10	
		Range		9	
		Interquartile Range		4	
		Skewness		1.486	.717
		Kurtosis		1.922	1.400

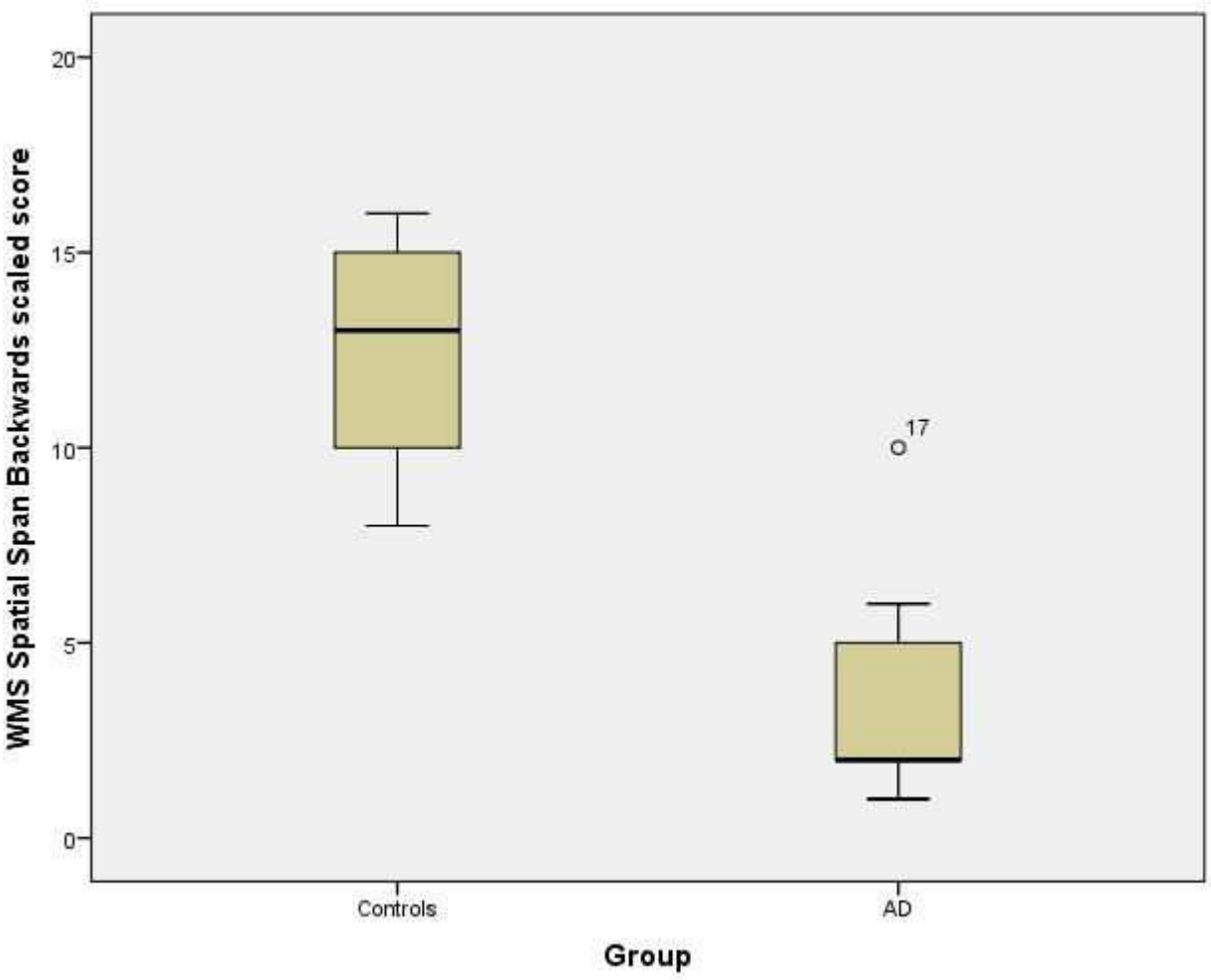
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
WMS Spatial Span Backwards scaled score	Based on Mean	.011	1	16	.918
	Based on Median	.111	1	16	.743
	Based on Median and with adjusted df	.111	1	12.226	.745
	Based on trimmed mean	.034	1	16	.855

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
WMS Spatial Span Backwards scaled score	Controls	.240	9	.144	.904	9	.277
	AD	.256	9	.092	.824	9	.039

a. Lilliefors Significance Correction



Digit-Span Total Scaled Score

Descriptives

	Group			Statistic	Std. Error
Digit Span Total Scaled Score	Controls	Mean		10.50	.847
		95% Confidence Interval for Mean	Lower Bound	8.58	
			Upper Bound	12.42	
		5% Trimmed Mean		10.44	
		Median		10.50	
		Variance		7.167	
		Std. Deviation		2.677	
		Minimum		7	
		Maximum		15	
		Range		8	
		Interquartile Range		4	
		Skewness		.152	.687
		Kurtosis		-1.026	1.334
	AD	Mean		7.09	.368
		95% Confidence Interval for Mean	Lower Bound	6.27	
			Upper Bound	7.91	
		5% Trimmed Mean		7.10	
		Median		7.00	
		Variance		1.491	
		Std. Deviation		1.221	
		Minimum		5	
		Maximum		9	
		Range		4	
		Interquartile Range		2	
		Skewness		.196	.661
		Kurtosis		-.109	1.279

Test of Homogeneity of Variance

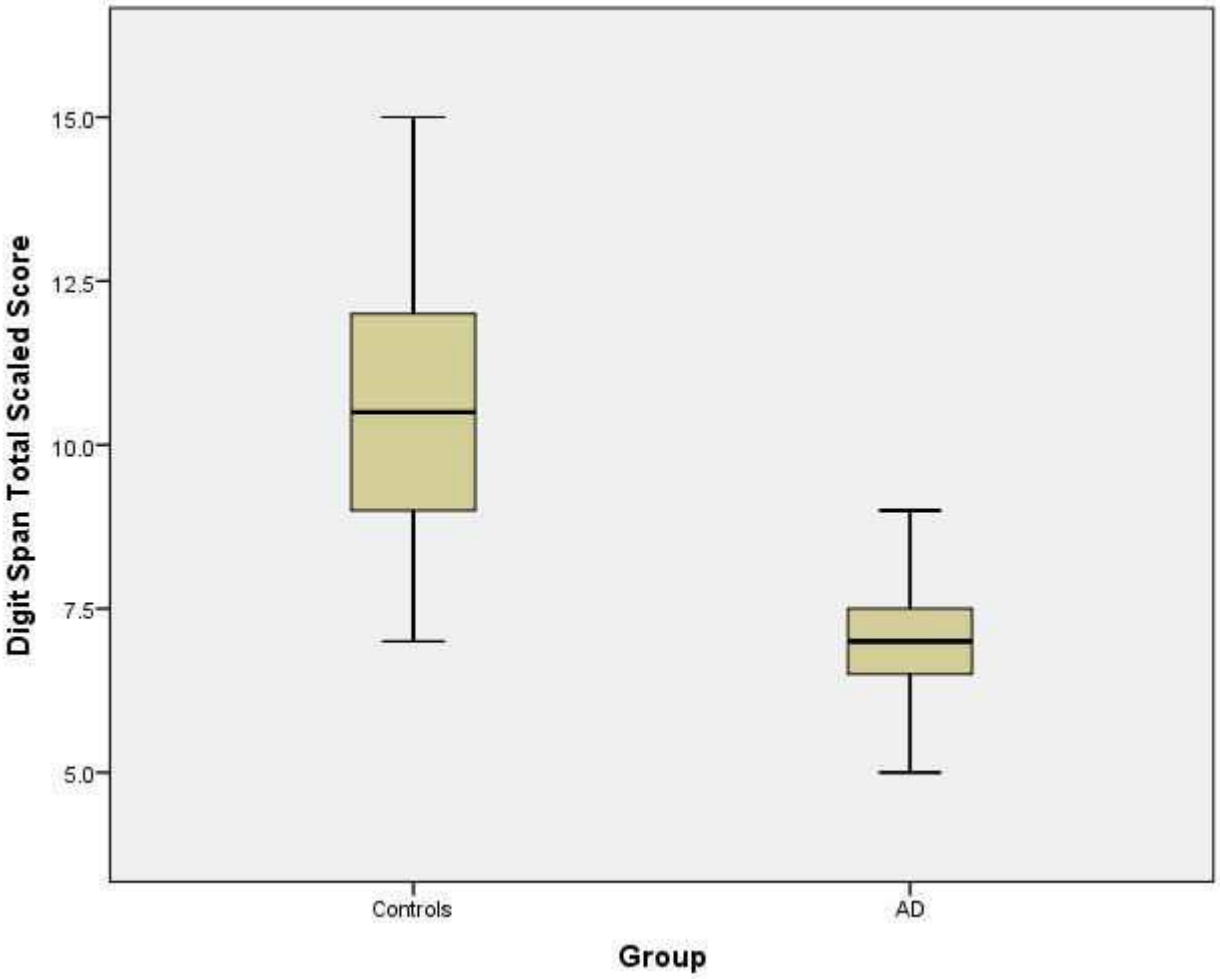
		Levene Statistic	df1	df2	Sig.
Digit Span Total Scaled Score	Based on Mean	11.234	1	19	.003
	Based on Median	11.360	1	19	.003
	Based on Median and with adjusted df	11.360	1	17.805	.003
	Based on trimmed mean	11.196	1	19	.003

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Digit Span Total Scaled Score	Controls	.212	10	.200*	.918	10	.341
	AD	.257	11	.041	.912	11	.255

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

a. Lilliefors Significance Correction



Forwards Digit-Span (DSF)

Descriptives

	Group			Statistic	Std. Error
Forward Digit Span Percentile Score	Controls	Mean		57.2000	8.13743
		95% Confidence Interval for Mean	Lower Bound	38.7919	
			Upper Bound	75.6081	
		5% Trimmed Mean		57.7778	
		Median		63.0000	
		Variance		662.178	
		Std. Deviation		25.73282	
		Minimum		18.00	
		Maximum		86.00	
		Range		68.00	
		Interquartile Range		53.25	
		Skewness		-.361	.687
		Kurtosis		-1.378	1.334
	AD	Mean		33.4000	8.78661
		95% Confidence Interval for Mean	Lower Bound	13.5233	
			Upper Bound	53.2767	
		5% Trimmed Mean		32.2778	
		Median		19.0000	
		Variance		772.044	
		Std. Deviation		27.78569	
		Minimum		5.00	
		Maximum		82.00	
		Range		77.00	
		Interquartile Range		49.50	
		Skewness		.757	.687
		Kurtosis		-.995	1.334

Test of Homogeneity of Variance

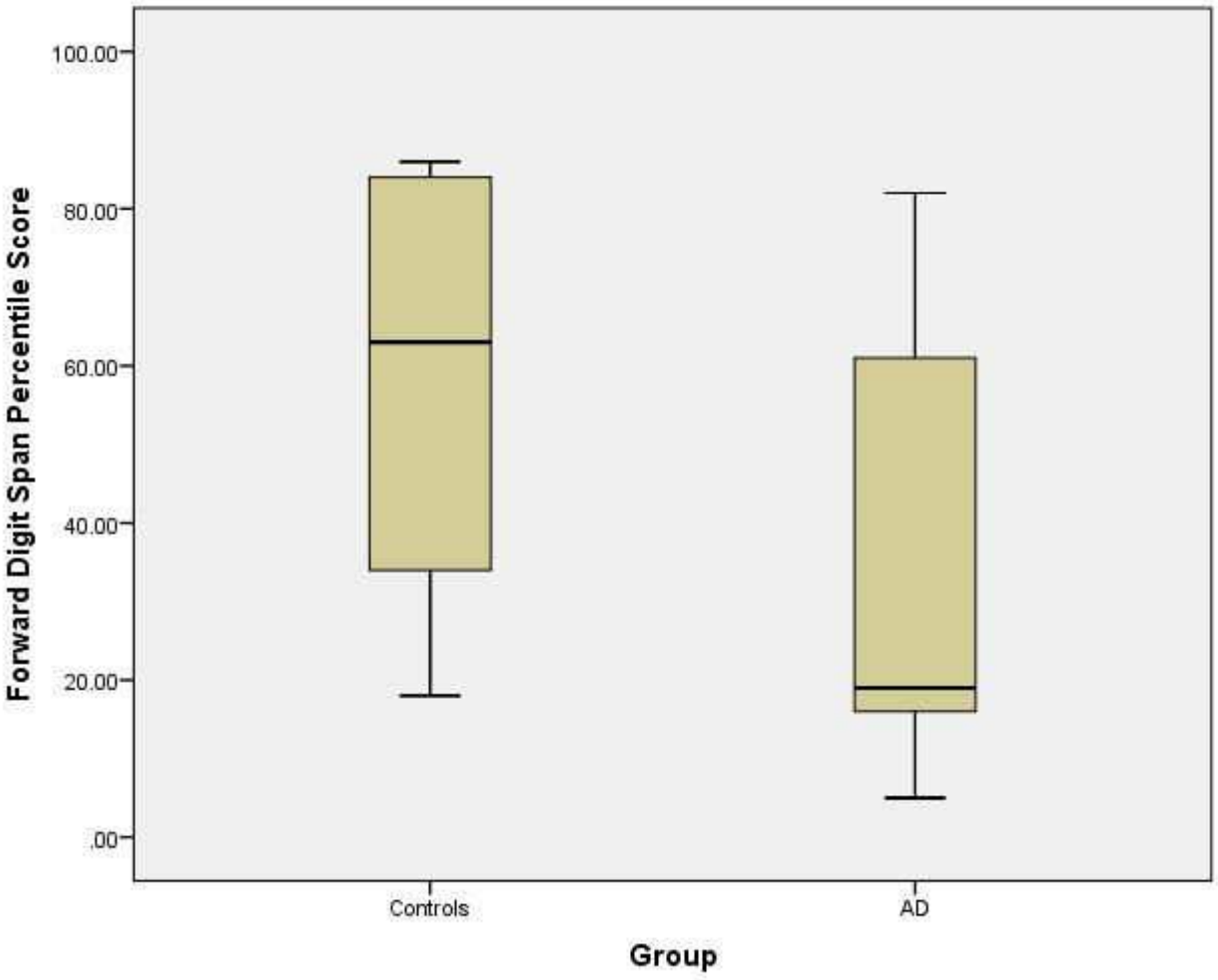
		Levene Statistic	df1	df2	Sig.
Forward Digit Span Percentile Score	Based on Mean	.177	1	18	.679
	Based on Median	.001	1	18	.981
	Based on Median and with adjusted df	.001	1	15.100	.981
	Based on trimmed mean	.151	1	18	.702

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Forward Digit Span Percentile Score	Controls	.163	10	.200*	.905	10	.248
	AD	.285	10	.021	.863	10	.083

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

a. Lilliefors Significance Correction



Backwards Digit-Span (DSB)

Descriptives

	Group			Statistic	Std. Error
Backward Digit Span Percentile Score	Controls	Mean		41.4000	7.18826
		95% Confidence Interval for Mean	Lower Bound	25.1390	
			Upper Bound	57.6610	
		5% Trimmed Mean		40.7778	
		Median		35.5000	
		Variance		516.711	
		Std. Deviation		22.73128	
		Minimum		12.00	
		Maximum		82.00	
		Range		70.00	
		Interquartile Range		35.25	
		Skewness		.401	.687
		Kurtosis		-.724	1.334
	AD	Mean		18.9000	3.99291
		95% Confidence Interval for Mean	Lower Bound	9.8674	
			Upper Bound	27.9326	
		5% Trimmed Mean		18.7222	
		Median		15.0000	
		Variance		159.433	
		Std. Deviation		12.62669	
		Minimum		4.00	
		Maximum		37.00	
		Range		33.00	
		Interquartile Range		24.75	
		Skewness		.558	.687
		Kurtosis		-1.173	1.334

Test of Homogeneity of Variance

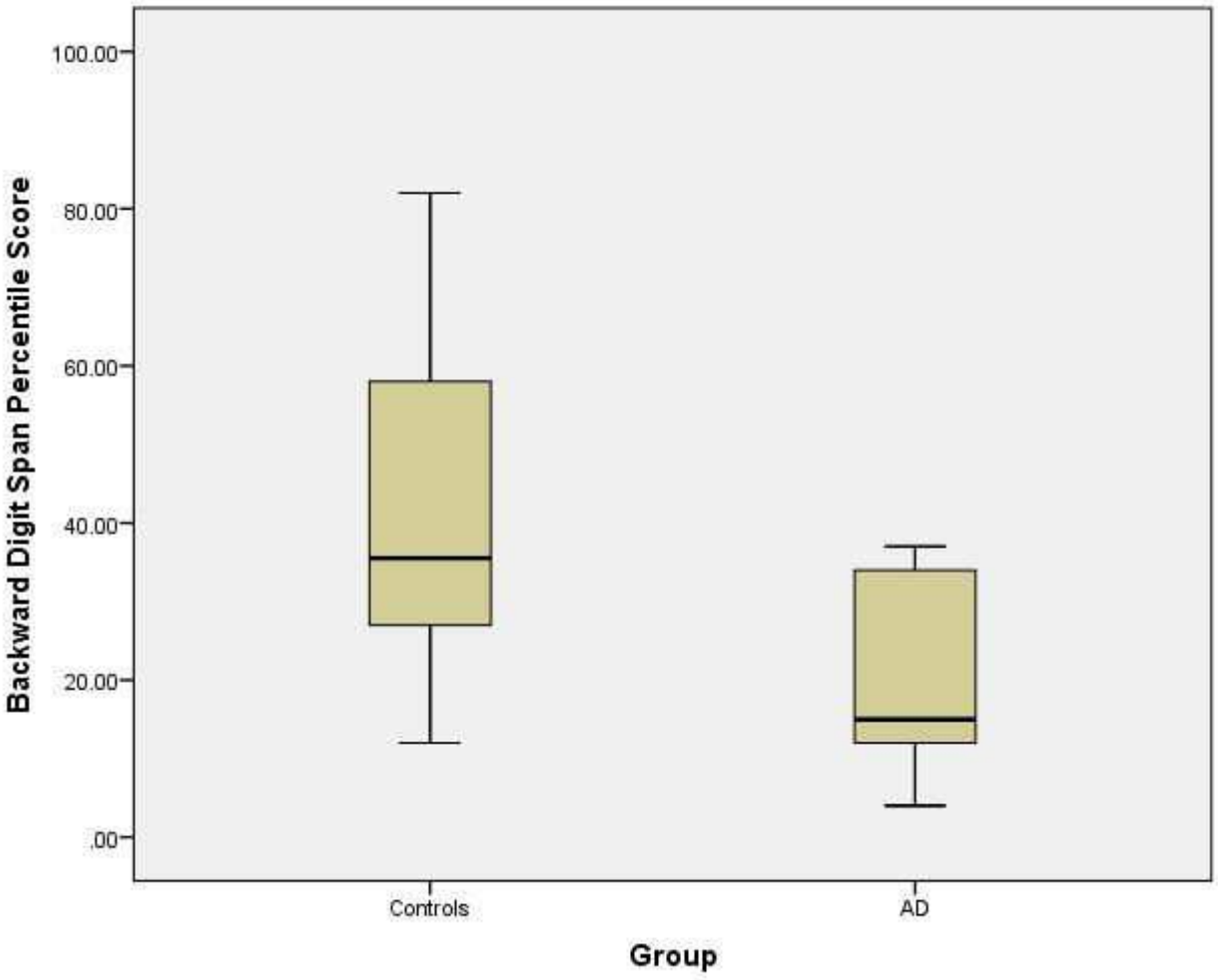
		Levene Statistic	df1	df2	Sig.
Backward Digit Span Percentile Score	Based on Mean	4.555	1	18	.047
	Based on Median	2.746	1	18	.115
	Based on Median and with adjusted df	2.746	1	15.325	.118
	Based on trimmed mean	4.307	1	18	.053

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
Backward Digit Span Percentile Score	Controls	.177	10	.200*	.941	10	.565
	AD	.260	10	.054	.851	10	.060

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

a. Lilliefors Significance Correction



Logical Memory 1st Recall

Descriptives

	Group			Statistic	Std. Error
Logical Memory I FIRST RECALL Scaled Score	Controls	Mean		11.80	.987
		95% Confidence Interval for Mean	Lower Bound	9.57	
			Upper Bound	14.03	
		5% Trimmed Mean		12.06	
		Median		12.50	
		Variance		9.733	
		Std. Deviation		3.120	
		Minimum		4	
		Maximum		15	
		Range		11	
		Interquartile Range		3	
		Skewness		-1.936	.687
		Kurtosis		4.572	1.334
	AD	Mean		5.43	1.232
		95% Confidence Interval for Mean	Lower Bound	2.41	
			Upper Bound	8.44	
		5% Trimmed Mean		5.31	
		Median		5.00	
		Variance		10.619	
		Std. Deviation		3.259	
		Minimum		2	
		Maximum		11	
		Range		9	
		Interquartile Range		6	
		Skewness		.718	.794
		Kurtosis		-.070	1.587

Test of Homogeneity of Variance

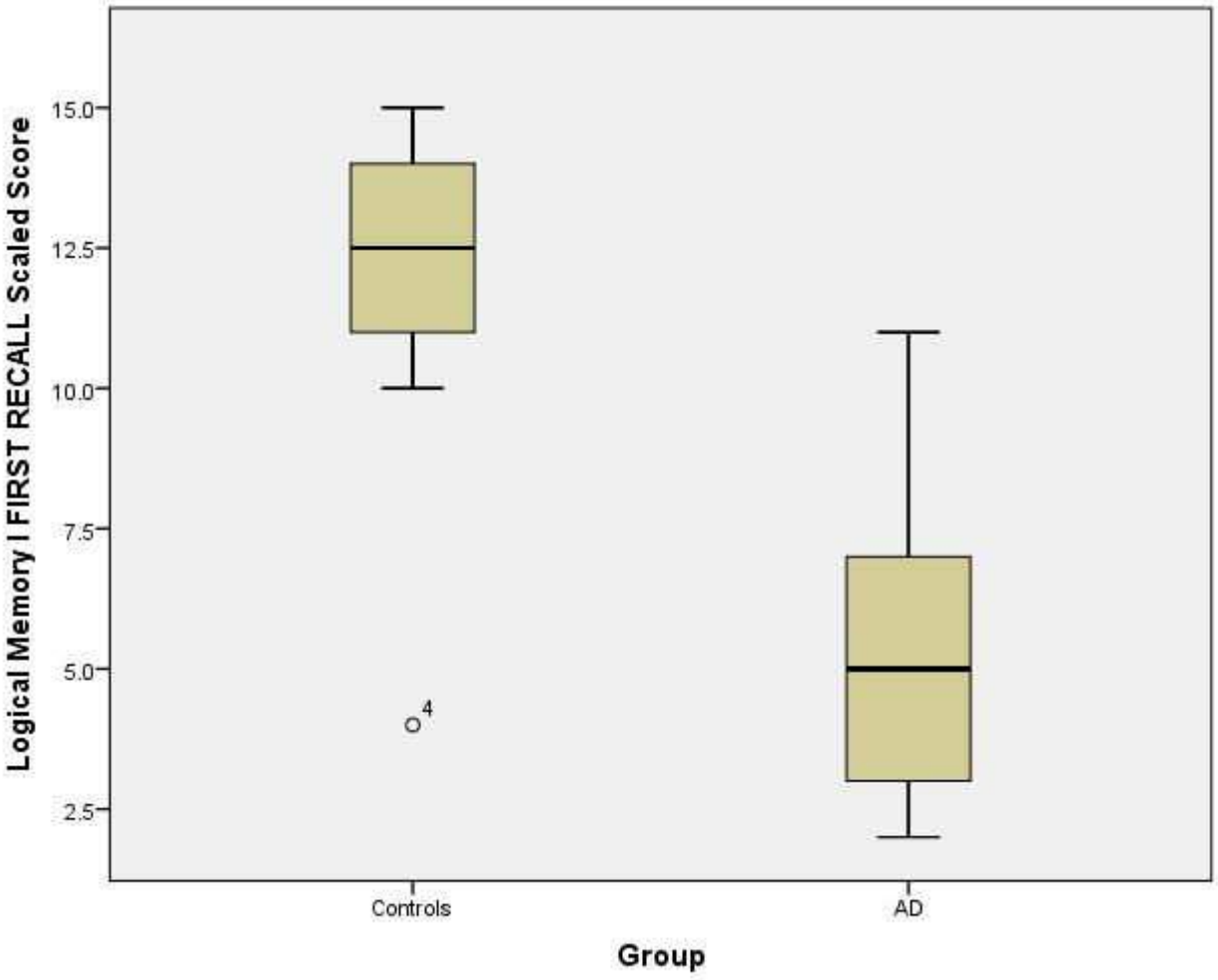
		Levene Statistic	df1	df2	Sig.
Logical Memory I FIRST RECALL Scaled Score	Based on Mean	.160	1	15	.694
	Based on Median	.149	1	15	.705
	Based on Median and with adjusted df	.149	1	14.522	.705
	Based on trimmed mean	.199	1	15	.662

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
Logical Memory I FIRST RECALL Scaled Score	Controls	.226	10	.161	.812	10	.020
	AD	.146	7	.200*	.933	7	.573

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

a. Lilliefors Significance Correction



Appendix G

Analyses to test parametric assumptions of the data (total sample)

Age (Years)

Descriptives

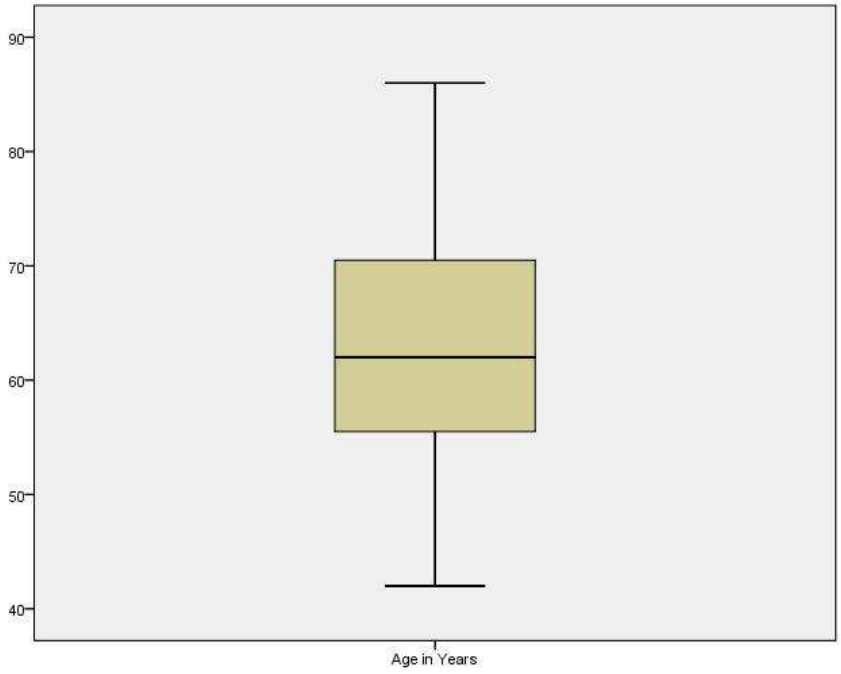
			Statistic	Std. Error
Age in Years	Mean		63.80	2.549
	95% Confidence Interval for Mean	Lower Bound	58.46	
		Upper Bound	69.14	
	5% Trimmed Mean		63.78	
	Median		62.00	
	Variance		129.958	
	Std. Deviation		11.400	
	Minimum		42	
	Maximum		86	
	Range		44	
	Interquartile Range		16	
	Skewness		.276	.512
	Kurtosis		-.167	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age in Years	.113	20	.200*	.974	20	.830

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

a. Lilliefors Significance Correction



Years Education

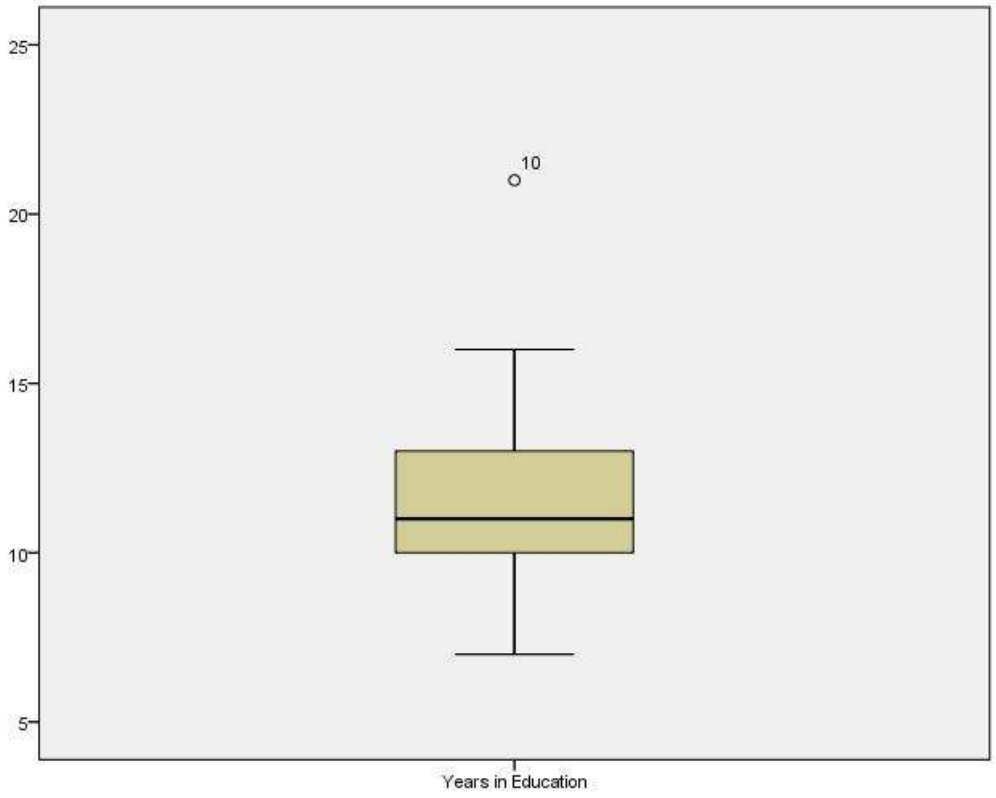
Descriptives

			Statistic	Std. Error
Years in Education	Mean		11.85	.682
	95% Confidence Interval for Mean	Lower Bound	10.42	
		Upper Bound	13.28	
	5% Trimmed Mean		11.61	
	Median		11.00	
	Variance		9.292	
	Std. Deviation		3.048	
	Minimum		7	
	Maximum		21	
	Range		14	
	Interquartile Range		3	
	Skewness		1.545	.512
	Kurtosis		3.370	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Years in Education	.222	20	.011	.831	20	.003

a. Lilliefors Significance Correction



DASS Anxiety

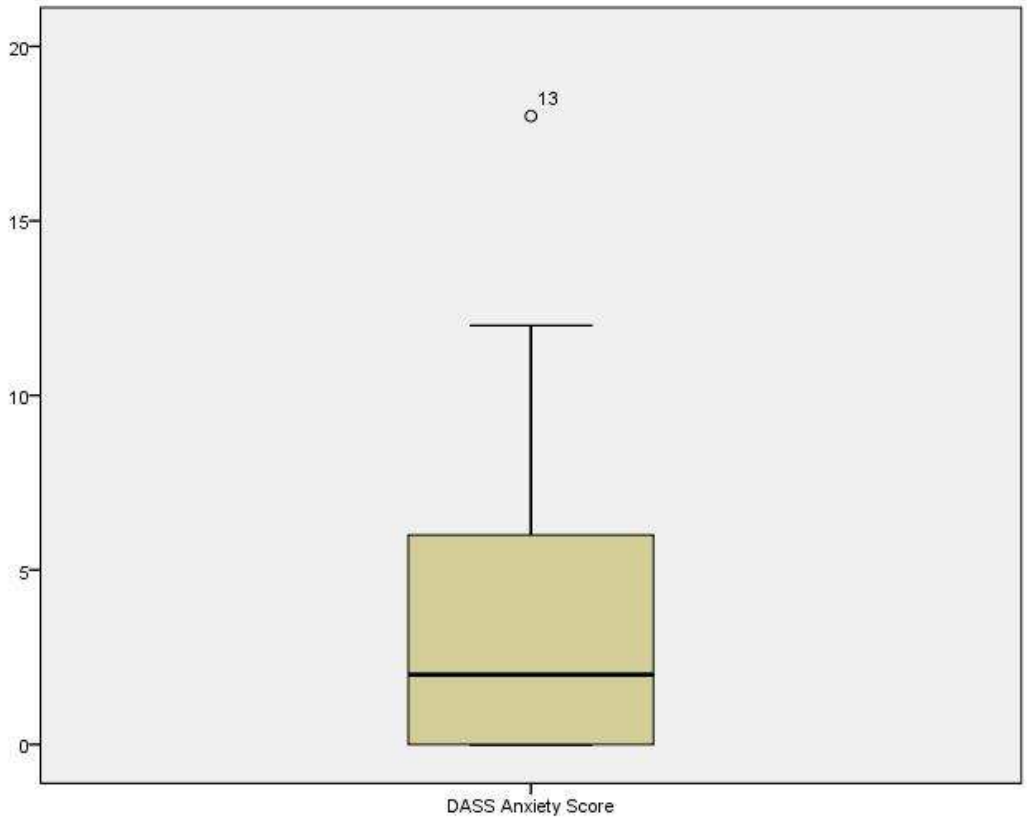
Descriptives

			Statistic	Std. Error
DASS Anxiety Score	Mean		3.90	1.119
	95% Confidence Interval for Mean	Lower Bound	1.56	
		Upper Bound	6.24	
	5% Trimmed Mean		3.33	
	Median		2.00	
	Variance		25.042	
	Std. Deviation		5.004	
	Minimum		0	
	Maximum		18	
	Range		18	
	Interquartile Range		6	
	Skewness		1.452	.512
	Kurtosis		1.951	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
DASS Anxiety Score	.232	20	.006	.798	20	.001

a. Lilliefors Significance Correction



DASS Depression

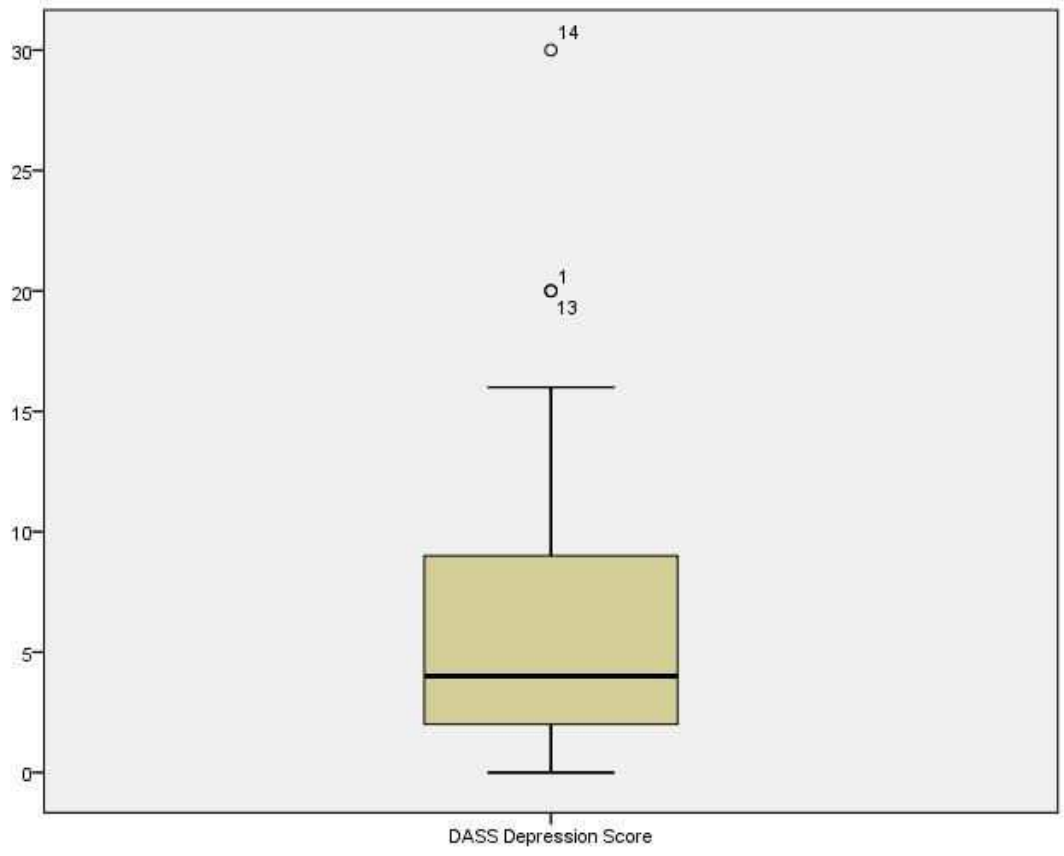
Descriptives

			Statistic	Std. Error
DASS Depression Score	Mean		7.10	1.838
	95% Confidence Interval for Mean	Lower Bound	3.25	
		Upper Bound	10.95	
	5% Trimmed Mean		6.22	
	Median		4.00	
	Variance		67.568	
	Std. Deviation		8.220	
	Minimum		0	
	Maximum		30	
	Range		30	
	Interquartile Range		8	
	Skewness		1.587	.512
	Kurtosis		1.978	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
DASS Depression Score	.247	20	.002	.787	20	.001

a. Lilliefors Significance Correction



DASS Stress

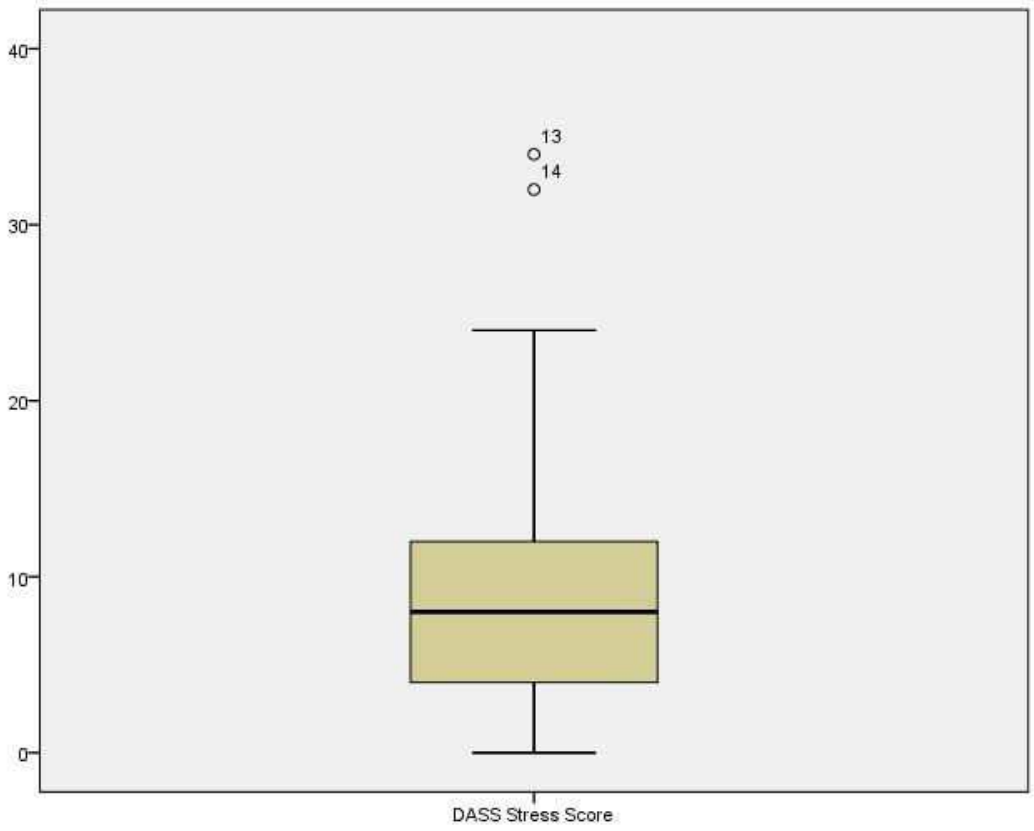
Descriptives

			Statistic	Std. Error
DASS Stress Score	Mean		10.10	2.208
	95% Confidence Interval for Mean	Lower Bound	5.48	
		Upper Bound	14.72	
	5% Trimmed Mean		9.33	
	Median		8.00	
	Variance		97.463	
	Std. Deviation		9.872	
	Minimum		0	
	Maximum		34	
	Range		34	
	Interquartile Range		9	
	Skewness		1.393	.512
	Kurtosis		1.313	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
DASS Stress Score	.254	20	.002	.835	20	.003

a. Lilliefors Significance Correction



VAF 1

Descriptives

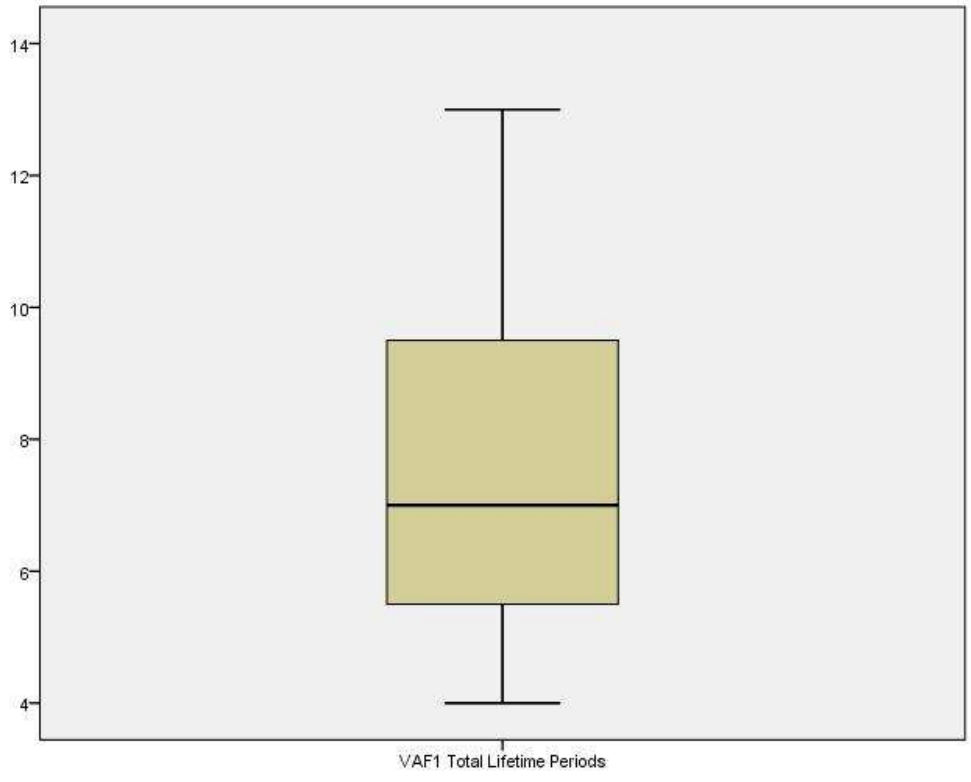
			Statistic	Std. Error
VAF1 Total Lifetime Periods	Mean		7.70	.603
	95% Confidence Interval for Mean	Lower Bound	6.44	
		Upper Bound	8.96	
	5% Trimmed Mean		7.61	
	Median		7.00	
	Variance		7.274	
	Std. Deviation		2.697	
	Minimum		4	
	Maximum		13	
	Range		9	
	Interquartile Range		5	
	Skewness		.569	.512
	Kurtosis		-.385	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
VAF1 Total Lifetime Periods	.152	20	.200*	.939	20	.233

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

a. Lilliefors Significance Correction



VAF 2

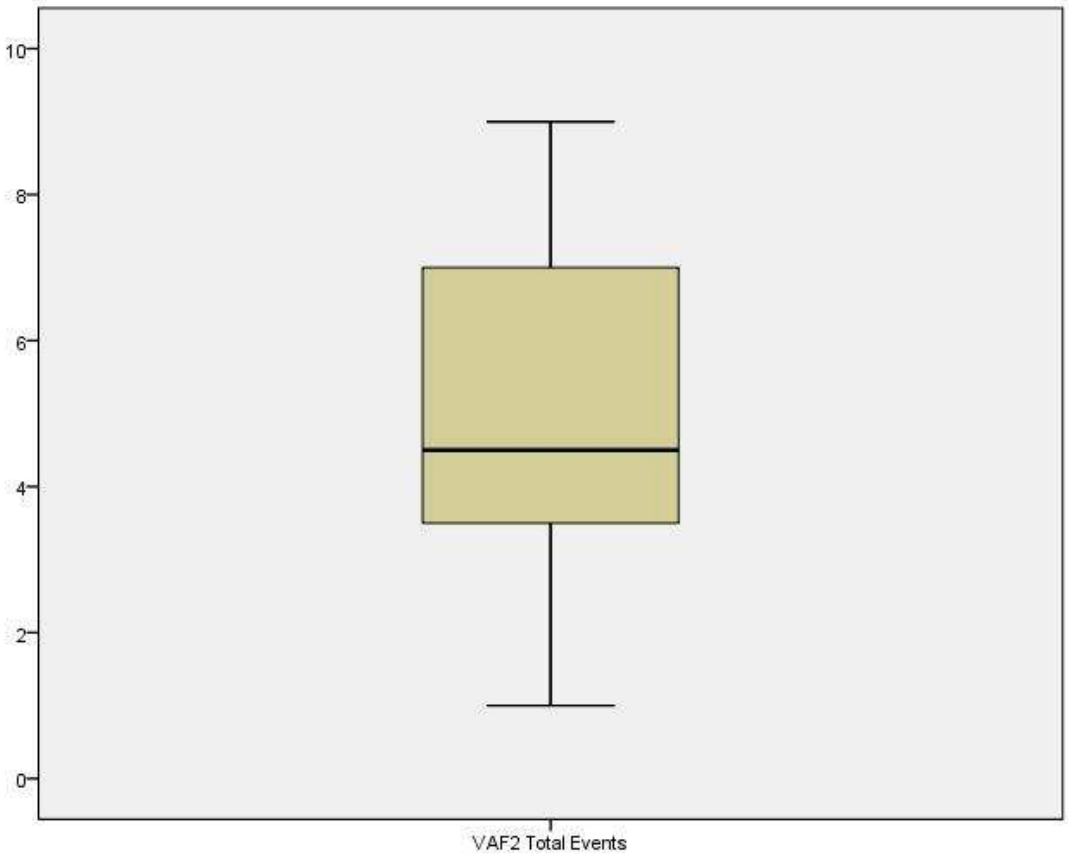
Descriptives

			Statistic	Std. Error
VAF2 Total Events	Mean		5.15	.539
	95% Confidence Interval for Mean	Lower Bound	4.02	
		Upper Bound	6.28	
	5% Trimmed Mean		5.17	
	Median		4.50	
	Variance		5.818	
	Std. Deviation		2.412	
	Minimum		1	
	Maximum		9	
	Range		8	
	Interquartile Range		4	
	Skewness		.330	.512
	Kurtosis		-.849	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
VAF2 Total Events	.183	20	.077	.928	20	.139

a. Lilliefors Significance Correction



VAF 3

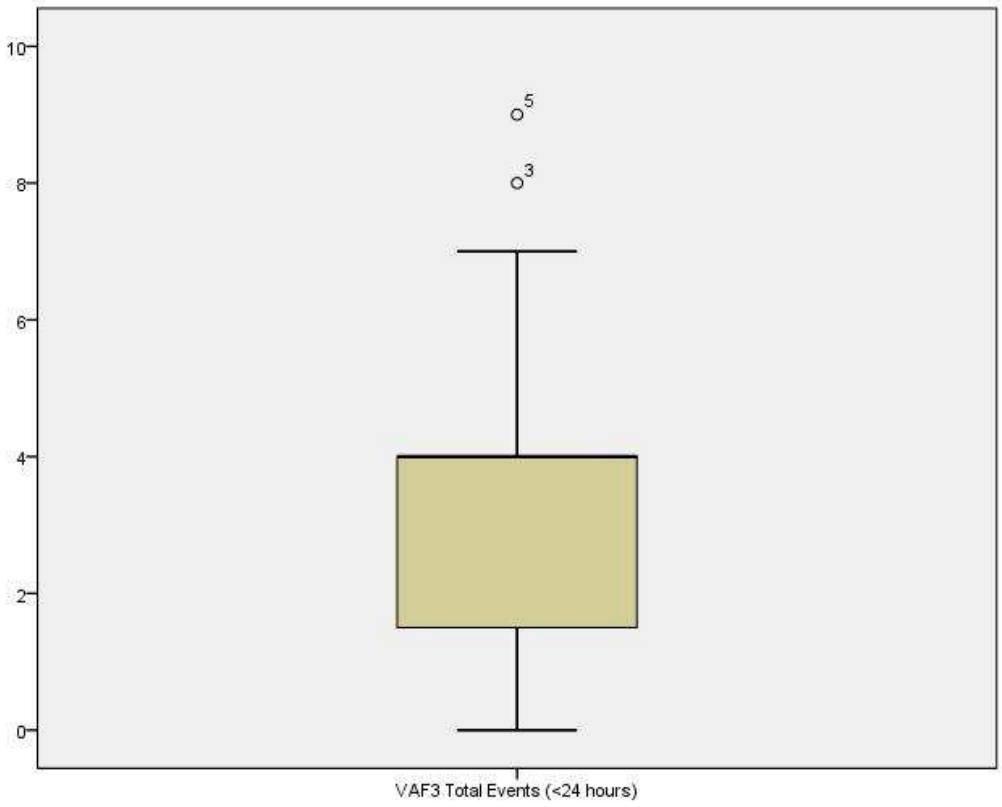
Descriptives

			Statistic	Std. Error
VAF3 Total Events (<24 hours)	Mean		3.75	.552
	95% Confidence Interval for Mean	Lower Bound	2.59	
		Upper Bound	4.91	
	5% Trimmed Mean		3.67	
	Median		4.00	
	Variance		6.092	
	Std. Deviation		2.468	
	Minimum		0	
	Maximum		9	
	Range		9	
	Interquartile Range		3	
	Skewness		.576	.512
	Kurtosis		-.141	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
VAF3 Total Events (<24 hours)	.260	20	.001	.906	20	.054

a. Lilliefors Significance Correction



VAF 4 Episodic AM (Percentage)

Descriptives

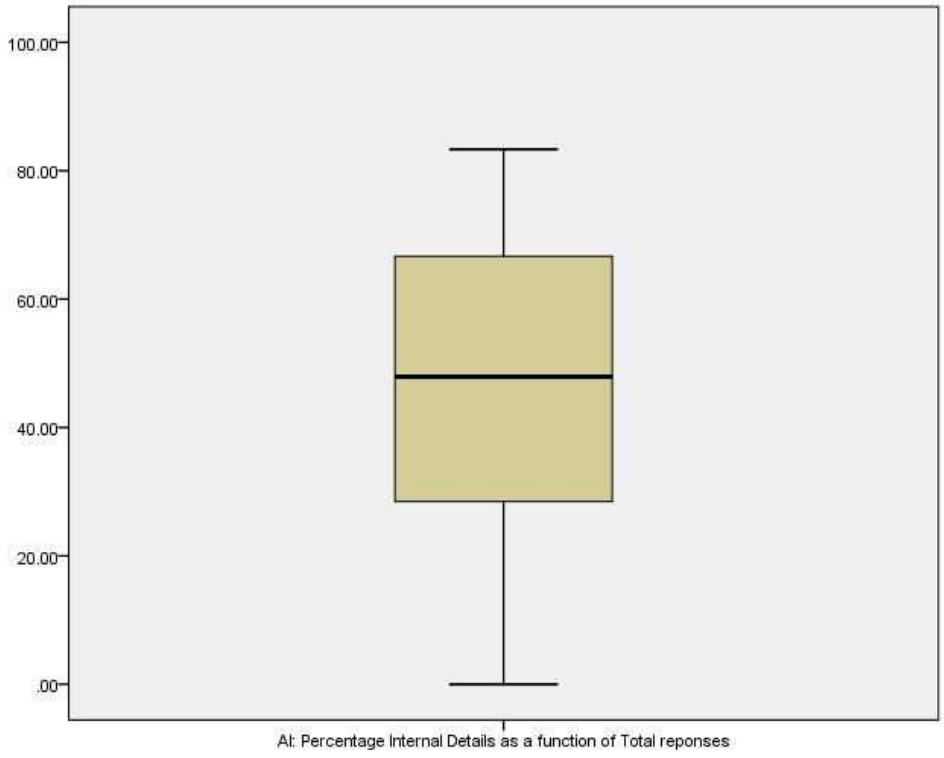
			Statistic	Std. Error
AI: Percentage Internal Details as a function of Total reponses	Mean		44.7130	5.56220
	95% Confidence Interval for Mean	Lower Bound	33.0712	
		Upper Bound	56.3548	
	5% Trimmed Mean		45.0517	
	Median		47.8950	
	Variance		618.762	
	Std. Deviation		24.87492	
	Minimum		.00	
	Maximum		83.33	
	Range		83.33	
	Interquartile Range		38.81	
	Skewness		-.288	.512
	Kurtosis		-.967	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
AI: Percentage Internal Details as a function of Total reponses	.143	20	.200*	.955	20	.444

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

a. Lilliefors Significance Correction



ACE-R Total (/100)

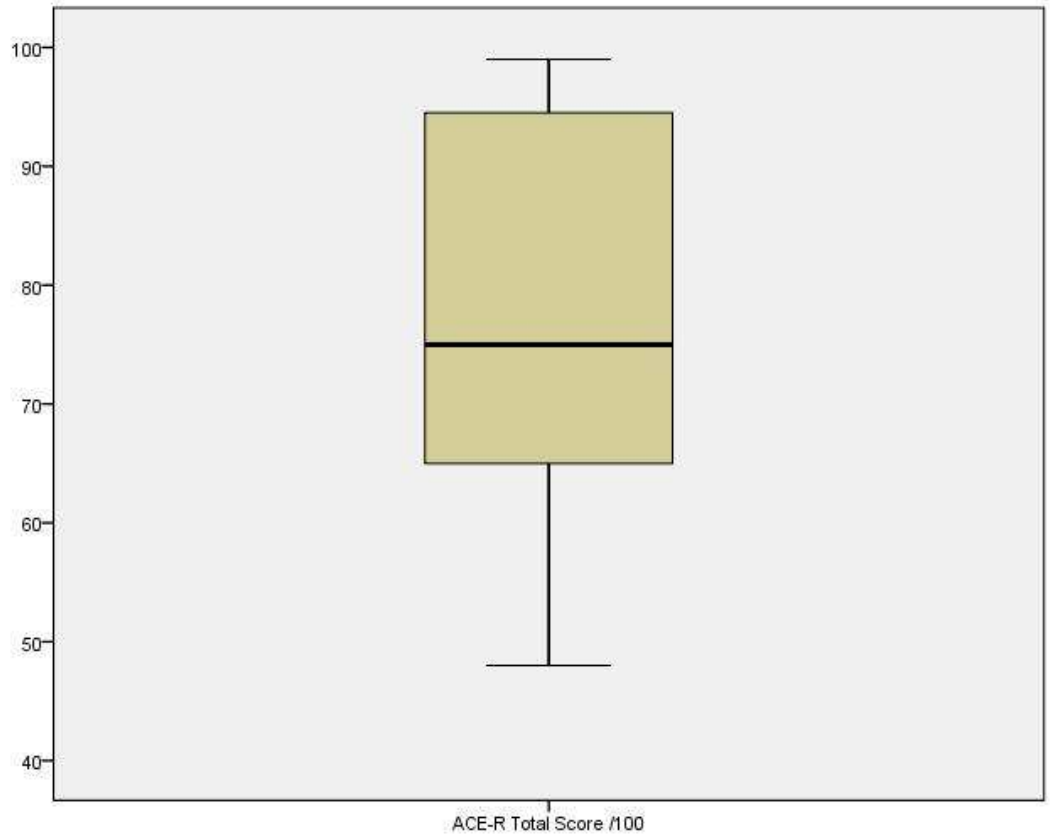
Descriptives

			Statistic	Std. Error
ACE-R Total Score /100	Mean		77.50	3.895
	95% Confidence Interval for Mean	Lower Bound	69.35	
		Upper Bound	85.65	
	5% Trimmed Mean		77.94	
	Median		75.00	
	Variance		303.421	
	Std. Deviation		17.419	
	Minimum		48	
	Maximum		99	
	Range		51	
	Interquartile Range		30	
	Skewness		-.276	.512
	Kurtosis		-1.358	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
ACE-R Total Score /100	.197	20	.040	.892	20	.029

a. Lilliefors Significance Correction



ACE-R Fluency (/14)

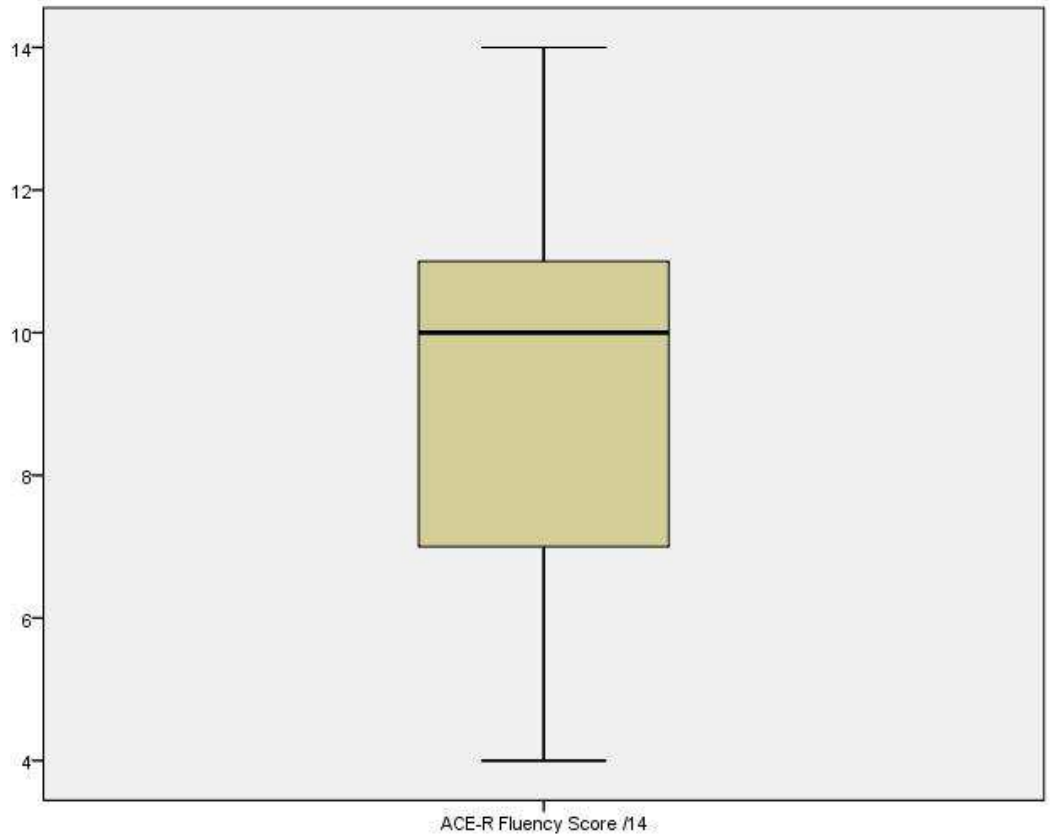
Descriptives

			Statistic	Std. Error
ACE-R Fluency Score /14	Mean		9.55	.630
	95% Confidence Interval for Mean	Lower Bound	8.23	
		Upper Bound	10.87	
	5% Trimmed Mean		9.61	
	Median		10.00	
	Variance		7.945	
	Std. Deviation		2.819	
	Minimum		4	
	Maximum		14	
	Range		10	
	Interquartile Range		4	
	Skewness		-.207	.512
	Kurtosis		-.770	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
ACE-R Fluency Score /14	.167	20	.145	.944	20	.287

a. Lilliefors Significance Correction



GNT (Percentiles)

Descriptives

			Statistic	Std. Error
Graded Naming Test Percentile Score	Mean		49.7474	7.95819
	95% Confidence Interval for Mean	Lower Bound	33.0278	
		Upper Bound	66.4669	
	5% Trimmed Mean		49.7693	
	Median		53.0000	
	Variance		1203.323	
	Std. Deviation		34.68894	
	Minimum		.10	
	Maximum		99.00	
	Range		98.90	
	Interquartile Range		68.00	
	Skewness		-.095	.524
	Kurtosis		-1.506	1.014

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Graded Naming Test Percentile Score	.154	19	.200*	.915	19	.091

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

a. Lilliefors Significance Correction

WTAR FSIQ

Descriptives

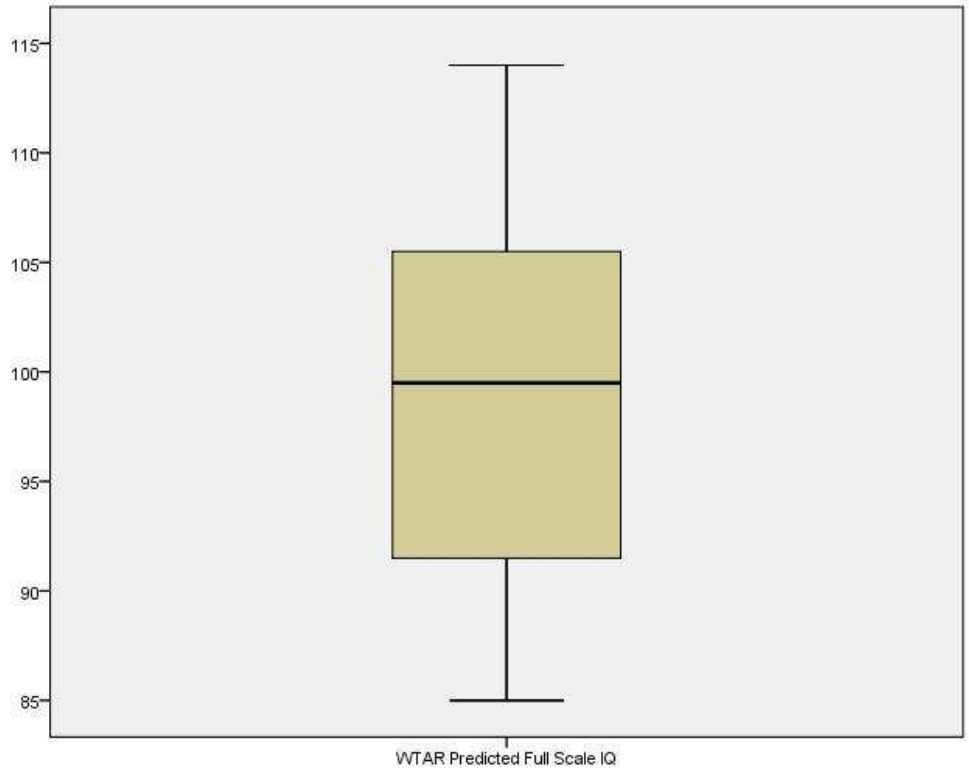
			Statistic	Std. Error
WTAR Predicted Full Scale IQ	Mean		99.05	1.916
	95% Confidence Interval for Mean	Lower Bound	95.04	
		Upper Bound	103.06	
	5% Trimmed Mean		99.00	
	Median		99.50	
	Variance		73.418	
	Std. Deviation		8.568	
	Minimum		85	
	Maximum		114	
	Range		29	
	Interquartile Range		15	
	Skewness		.079	.512
	Kurtosis		-.699	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
WTAR Predicted Full Scale IQ	.106	20	.200*	.960	20	.545

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

a. Lilliefors Significance Correction



Spatial Span Scaled Score

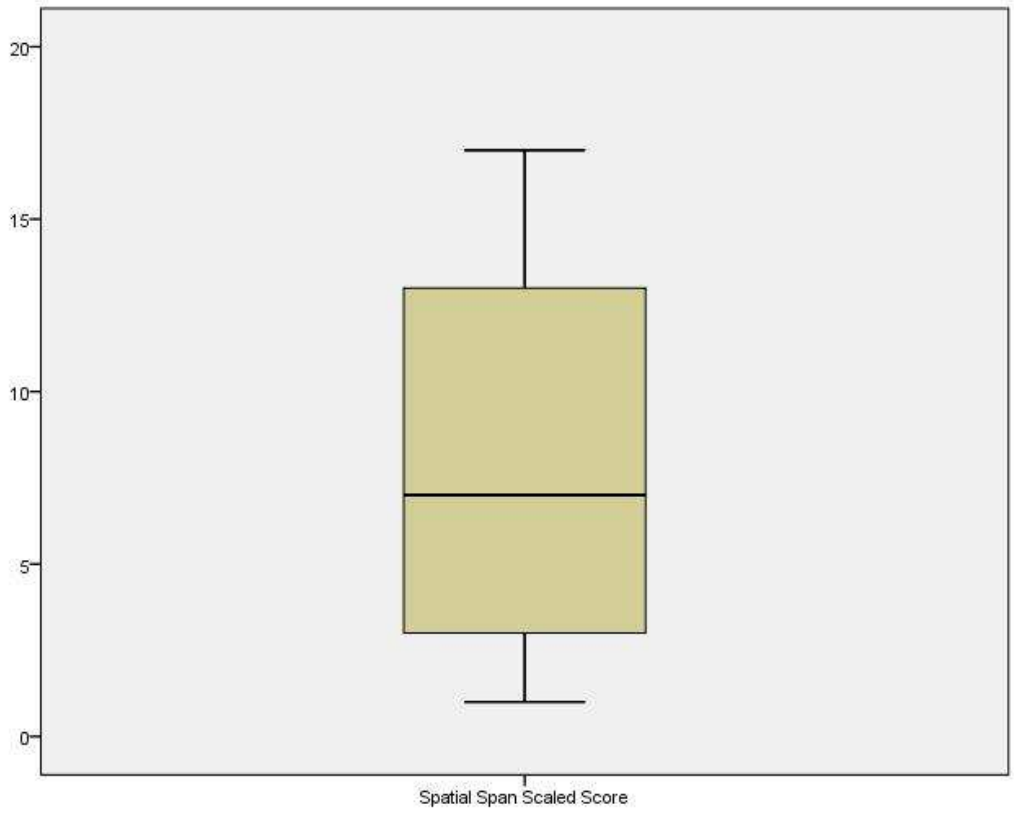
Descriptives

			Statistic	Std. Error
Spatial Span Scaled Score	Mean		7.76	1.250
	95% Confidence Interval for Mean	Lower Bound	5.11	
		Upper Bound	10.41	
	5% Trimmed Mean		7.63	
	Median		7.00	
	Variance		26.566	
	Std. Deviation		5.154	
	Minimum		1	
	Maximum		17	
	Range		16	
	Interquartile Range		10	
	Skewness		.246	.550
	Kurtosis		-1.407	1.063

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Spatial Span Scaled Score	.179	17	.149	.909	17	.094

a. Lilliefors Significance Correction



Forwards Spatial-Span (SSF)

Descriptives

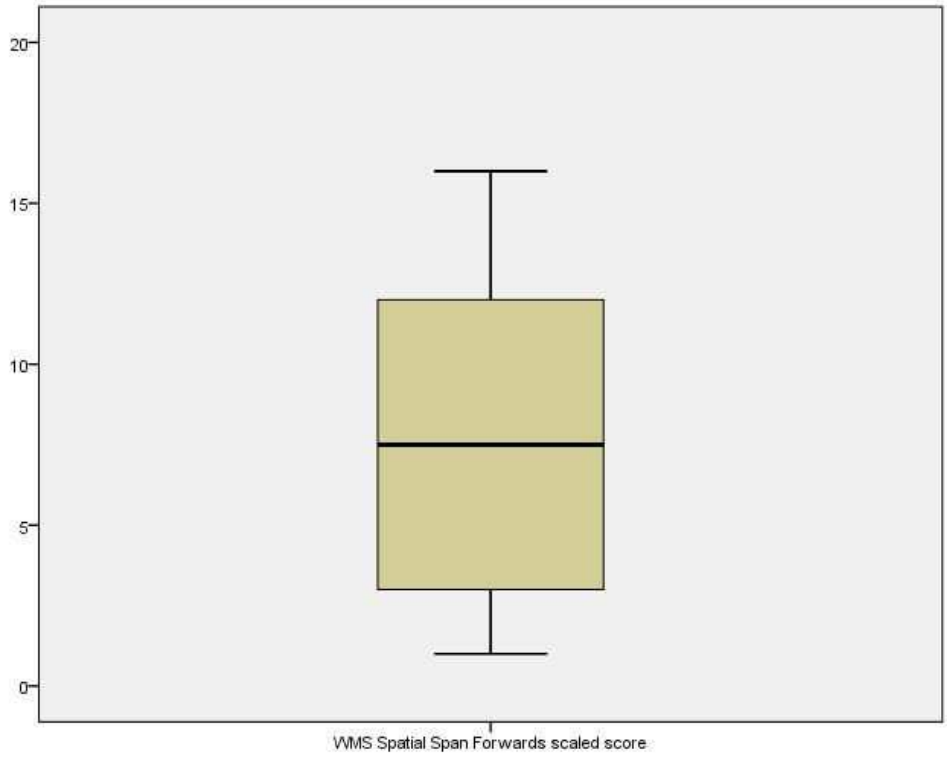
			Statistic	Std. Error
WMS Spatial Span Forwards scaled score	Mean		7.50	1.097
	95% Confidence Interval for Mean	Lower Bound	5.18	
		Upper Bound	9.82	
	5% Trimmed Mean		7.39	
	Median		7.50	
	Variance		21.676	
	Std. Deviation		4.656	
	Minimum		1	
	Maximum		16	
	Range		15	
	Interquartile Range		9	
	Skewness		.275	.536
	Kurtosis		-1.194	1.038

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
WMS Spatial Span Forwards scaled score	.149	18	.200*	.942	18	.312

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

a. Lilliefors Significance Correction



Backwards Spatial-Span (SSB)

Descriptives

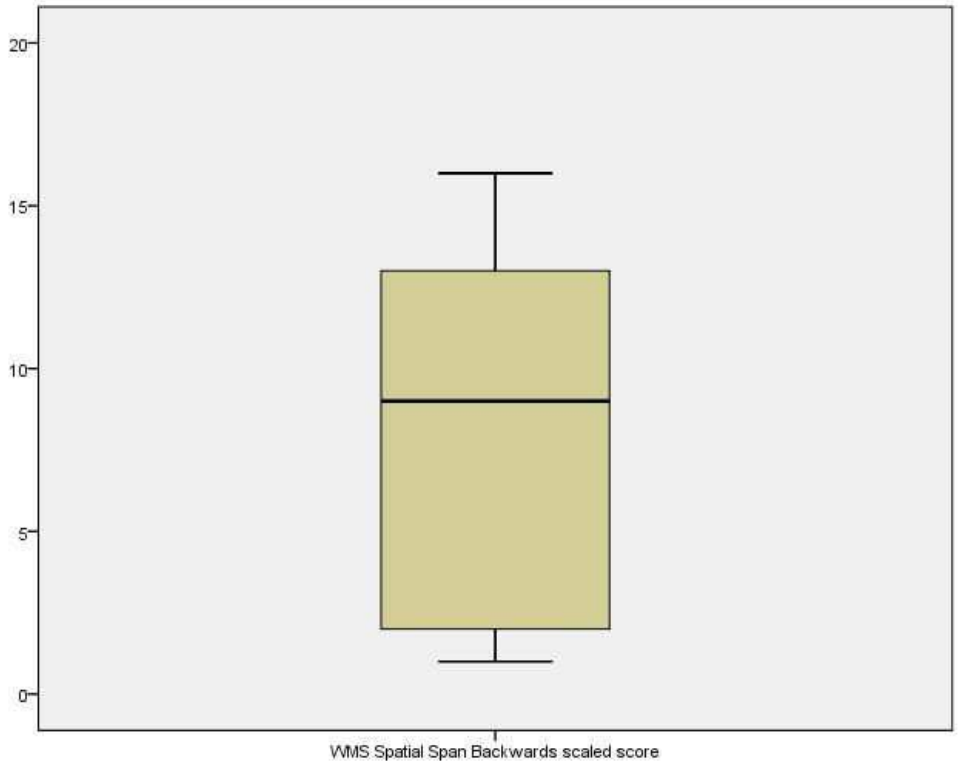
			Statistic	Std. Error
WMS Spatial Span Backwards scaled score	Mean		8.11	1.288
	95% Confidence Interval for Mean	Lower Bound	5.39	
		Upper Bound	10.83	
	5% Trimmed Mean		8.07	
	Median		9.00	
	Variance		29.869	
	Std. Deviation		5.465	
	Minimum		1	
	Maximum		16	
	Range		15	
	Interquartile Range		12	
	Skewness		.037	.536
	Kurtosis		-1.587	1.038

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
WMS Spatial Span Backwards scaled score	.158	18	.200*	.894	18	.046

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

a. Lilliefors Significance Correction



Digit-Span Total Scaled Score

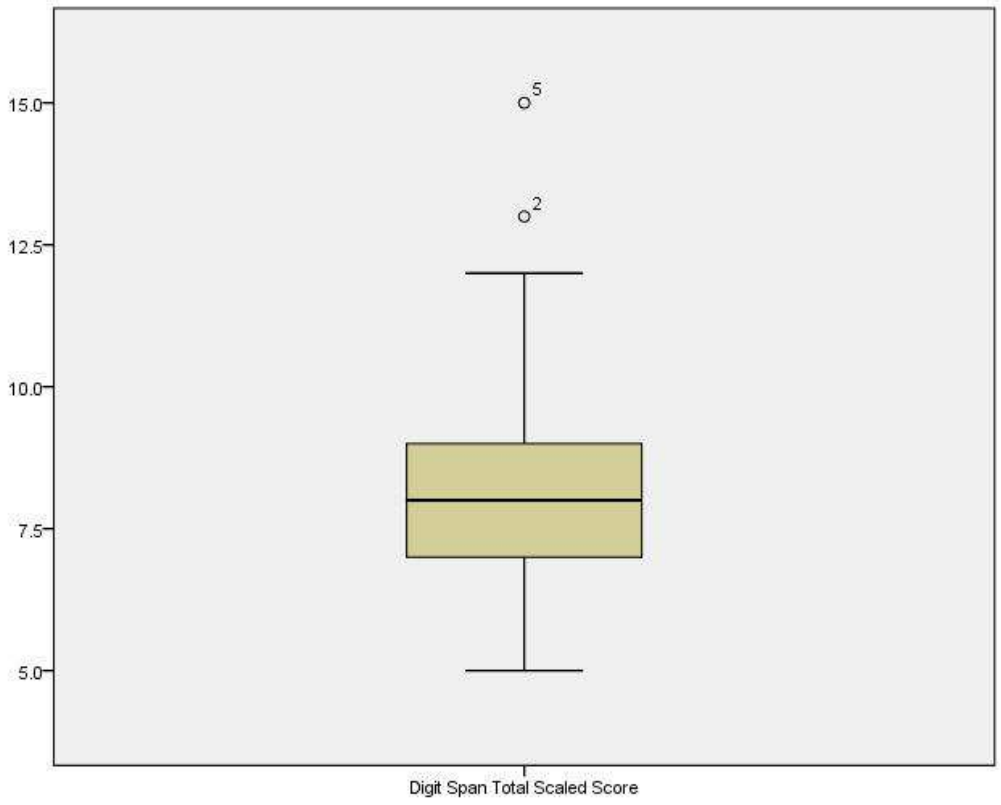
Descriptives

			Statistic	Std. Error
Digit Span Total Scaled Score	Mean		8.71	.578
	95% Confidence Interval for Mean	Lower Bound	7.51	
		Upper Bound	9.92	
	5% Trimmed Mean		8.57	
	Median		8.00	
	Variance		7.014	
	Std. Deviation		2.648	
	Minimum		5	
	Maximum		15	
	Range		10	
	Interquartile Range		4	
	Skewness		.912	.501
	Kurtosis		.071	.972

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Digit Span Total Scaled Score	.219	21	.010	.888	21	.021

a. Lilliefors Significance Correction



Forwards Digit-Span (DSF)

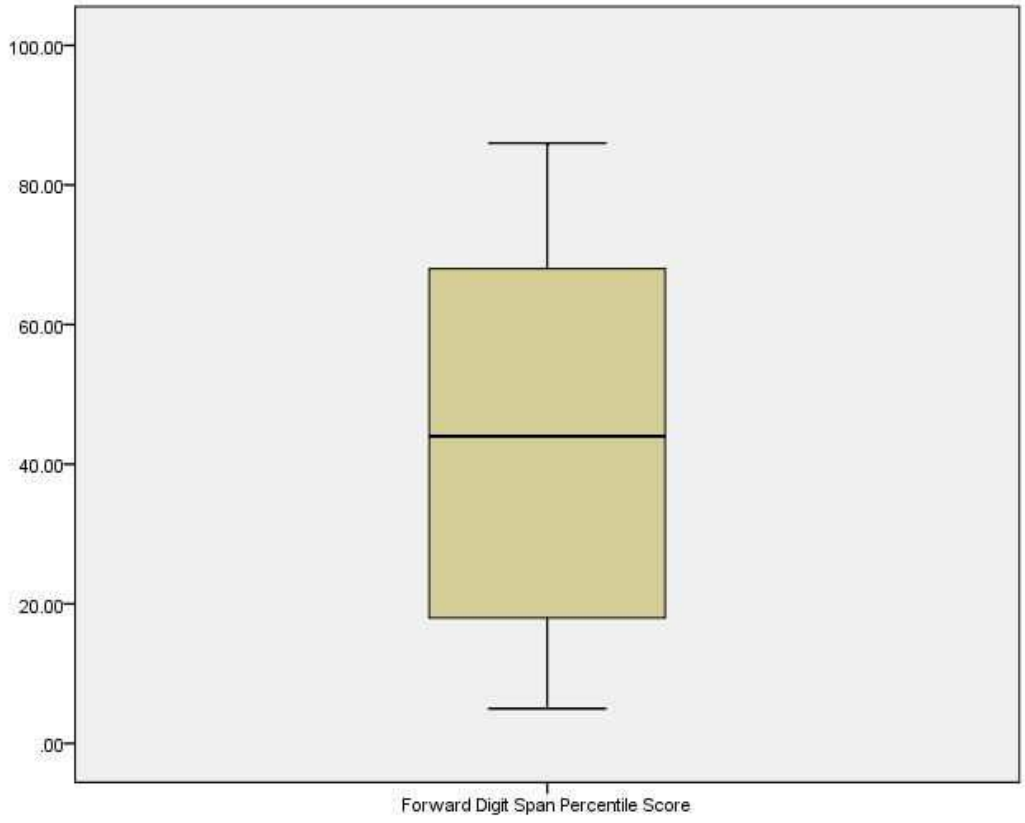
Descriptives

			Statistic	Std. Error
Forward Digit Span Percentile Score	Mean		45.3000	6.43596
	95% Confidence Interval for Mean	Lower Bound	31.8294	
		Upper Bound	58.7706	
	5% Trimmed Mean		45.2778	
	Median		44.0000	
	Variance		828.432	
	Std. Deviation		28.78249	
	Minimum		5.00	
	Maximum		86.00	
	Range		81.00	
	Interquartile Range		50.00	
	Skewness		.092	.512
	Kurtosis		-1.562	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Forward Digit Span Percentile Score	.181	20	.086	.898	20	.038

a. Lilliefors Significance Correction



Backwards Digit-Span

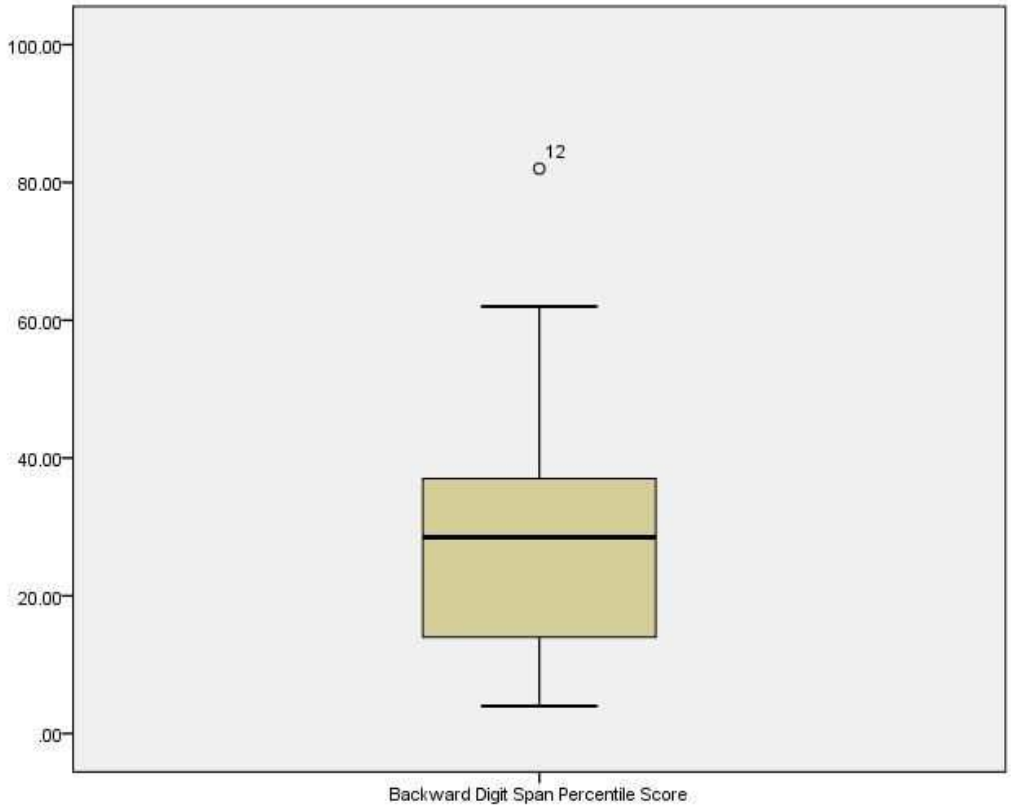
Descriptives

			Statistic	Std. Error
Backward Digit Span Percentile Score	Mean		30.1500	4.76184
	95% Confidence Interval for Mean	Lower Bound	20.1834	
		Upper Bound	40.1166	
	5% Trimmed Mean		28.7222	
	Median		28.5000	
	Variance		453.503	
	Std. Deviation		21.29560	
	Minimum		4.00	
	Maximum		82.00	
	Range		78.00	
	Interquartile Range		23.00	
	Skewness		.911	.512
	Kurtosis		.287	.992

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Backward Digit Span Percentile Score	.182	20	.083	.904	20	.049

a. Lilliefors Significance Correction



Appendix H

Power Analysis

Clark-Carter (2010) recommends a total sample of 20-25 participants in order to detect a strong correlation between variables and, using the G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009), based on previously reported effect sizes (e.g. Moses et al., 2004; Piolino et al., 2010) a total sample of 23 participants was estimated to achieve 81% power.

In order to detect a large mediating effect of WM and verbal fluency on episodic AM, a total sample of 34 was estimated based on recommendations for bias-corrected, bootstrapped mediation analysis by Fritz and Mackinnon (2007). Clark-Carter (2010) recommends a total sample of 36 for a three-predictor regression model with large effects and this was supported by a conservative G*Power calculation based on previously published regression models in healthy ageing samples (Piolino et al., 2010).

Appendix I

NHS Research Ethics Committee Approval

This has been removed from the electronic copy

Appendix J

Anonymised NHS Site R&D Approval Letters

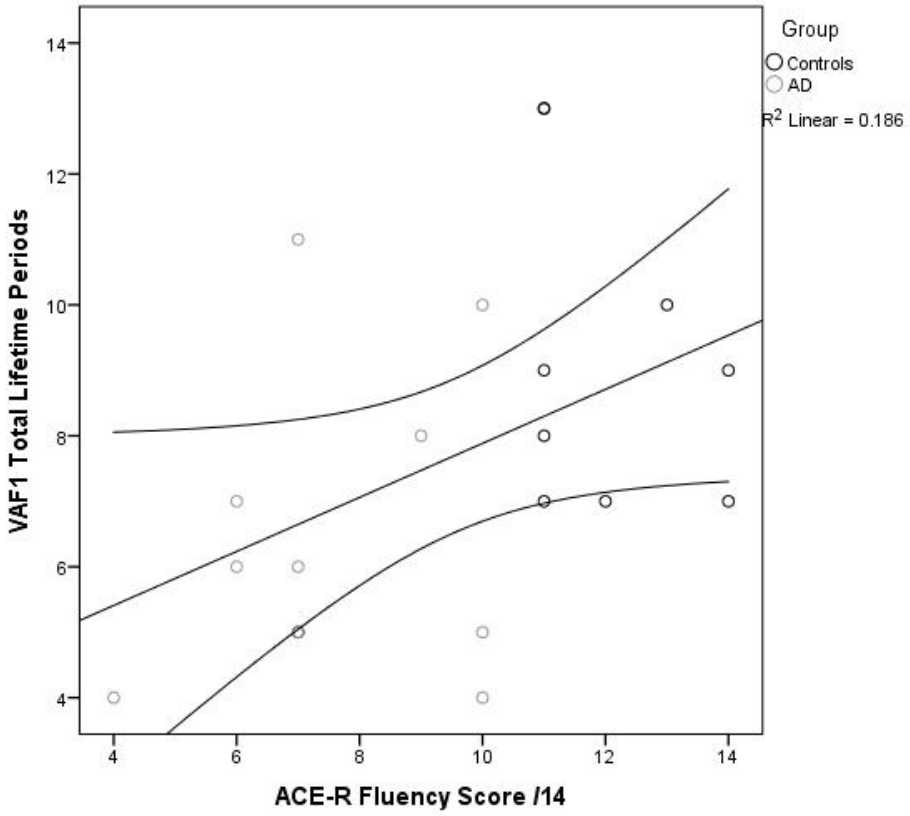
These have been removed from the electronic copy

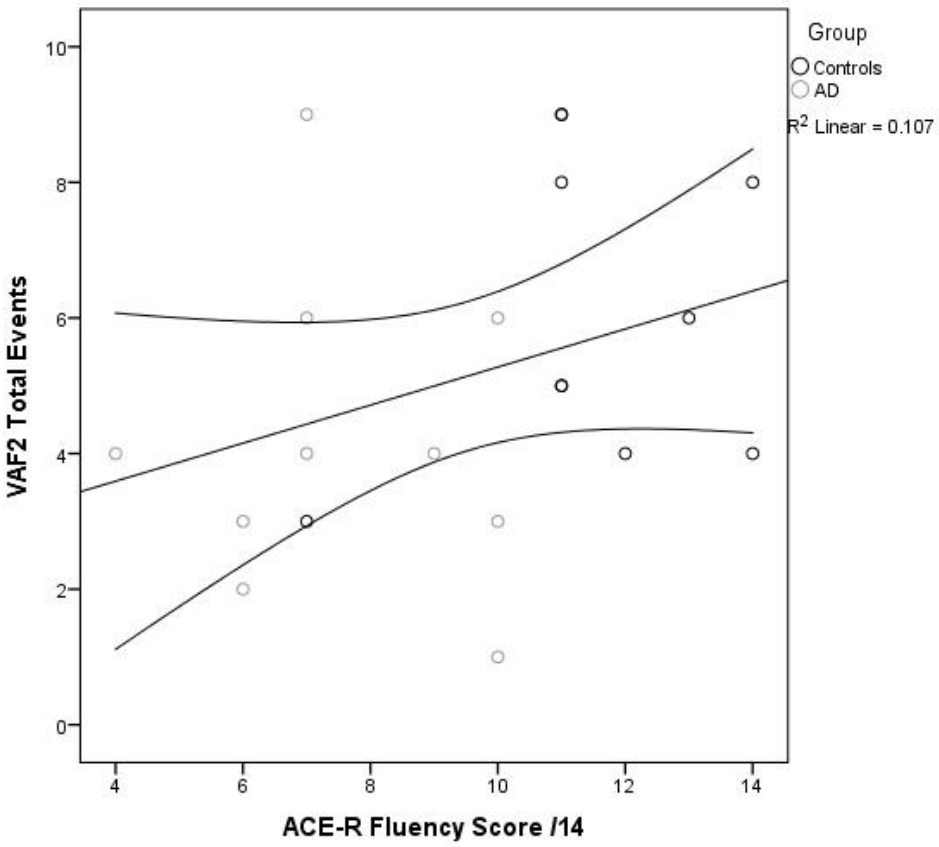
Appendix K

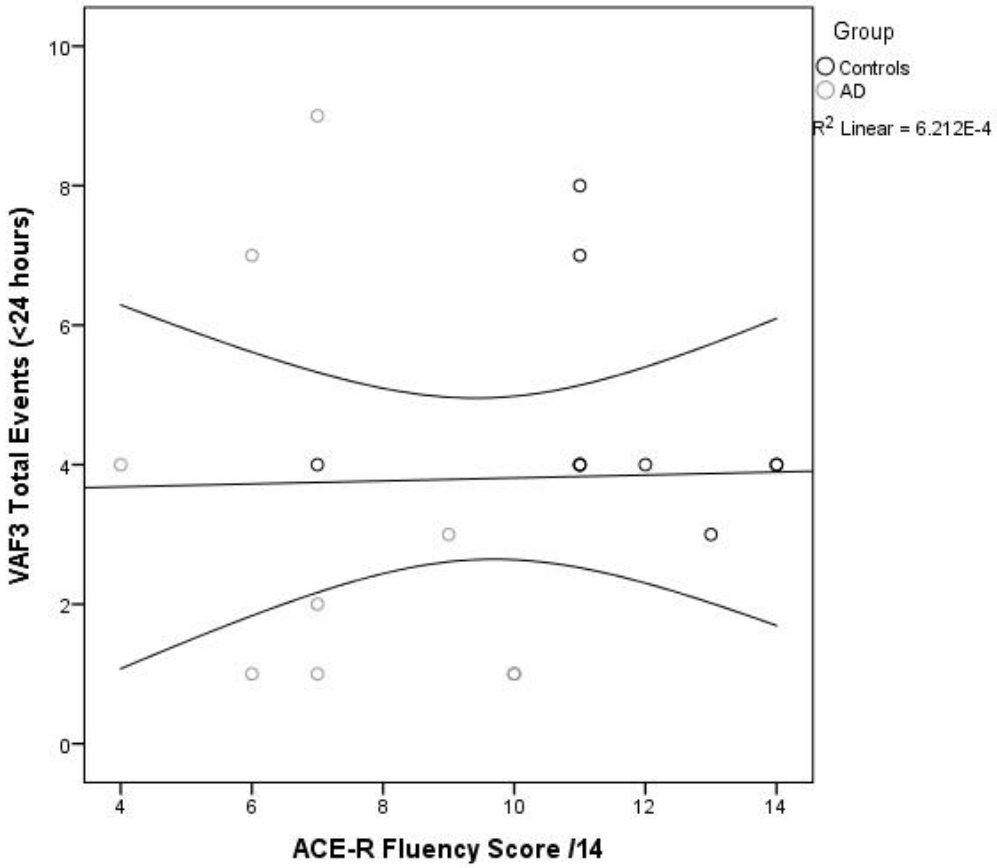
Example autobiographical memory response scoring

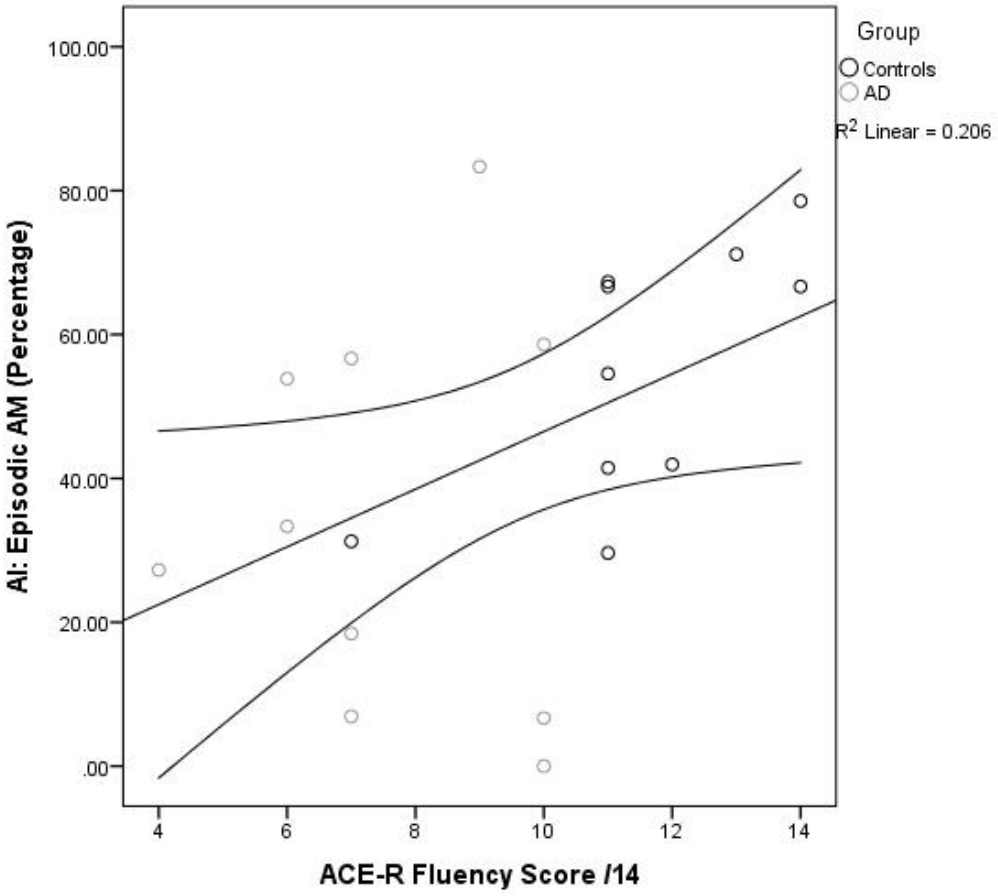
This has been removed from the electronic copy

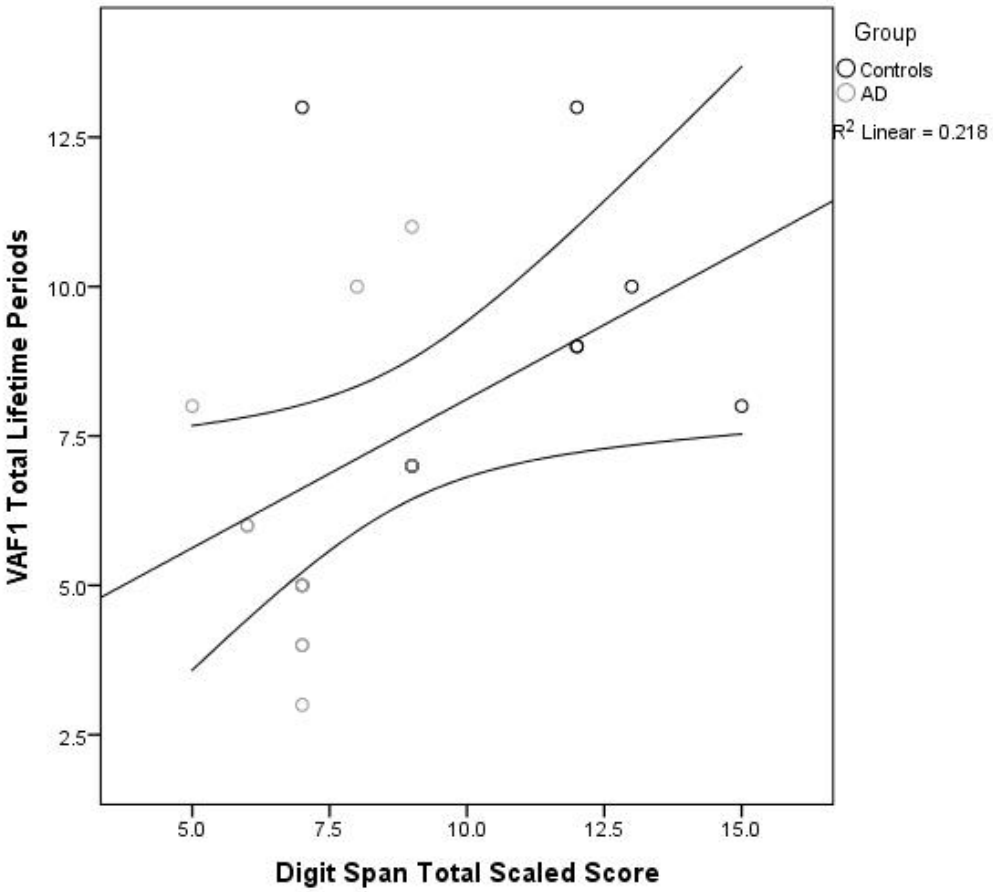
Appendix L

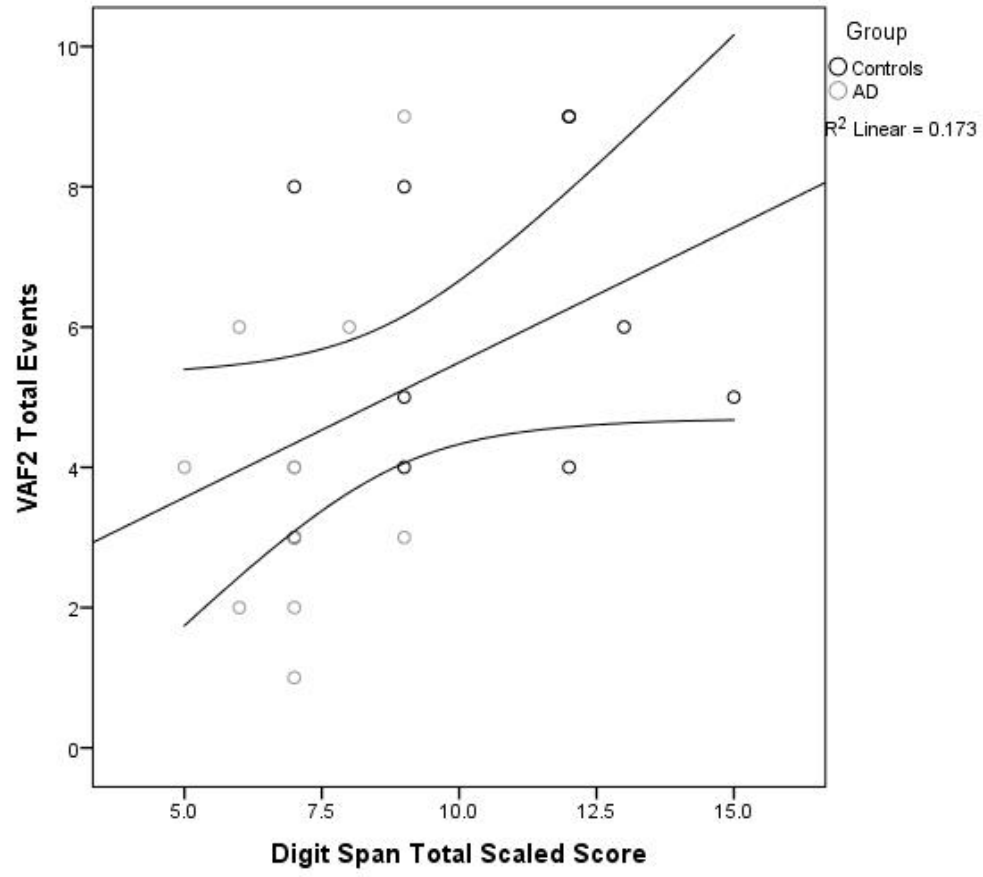

Group
Controls
AD
R^2 Linear = 0.186
VAF1 Total Lifetime Periods
ACE-R Fluency Score /14
14
12
10
8
6
4
4
6
8
10
12
14

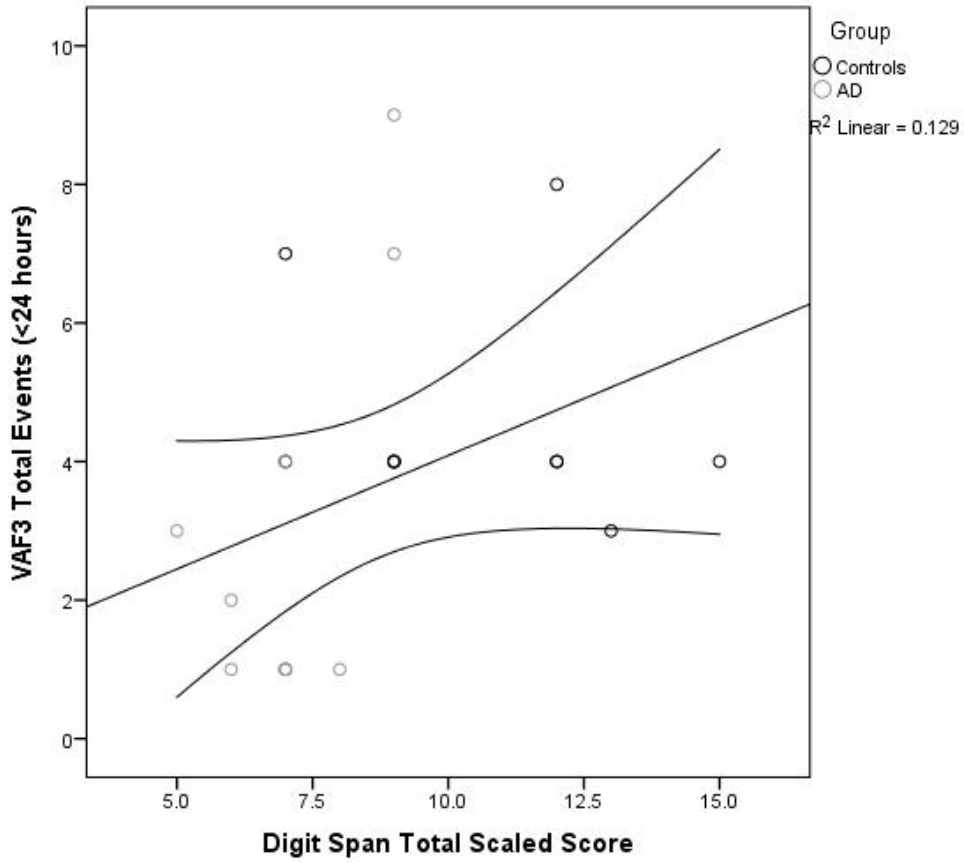

Group
Controls
AD
R^2 Linear = 0.107
VAF2 Total Events
ACE-R Fluency Score /14
10
8
6
4
2
0
4
6
8
10
12
14

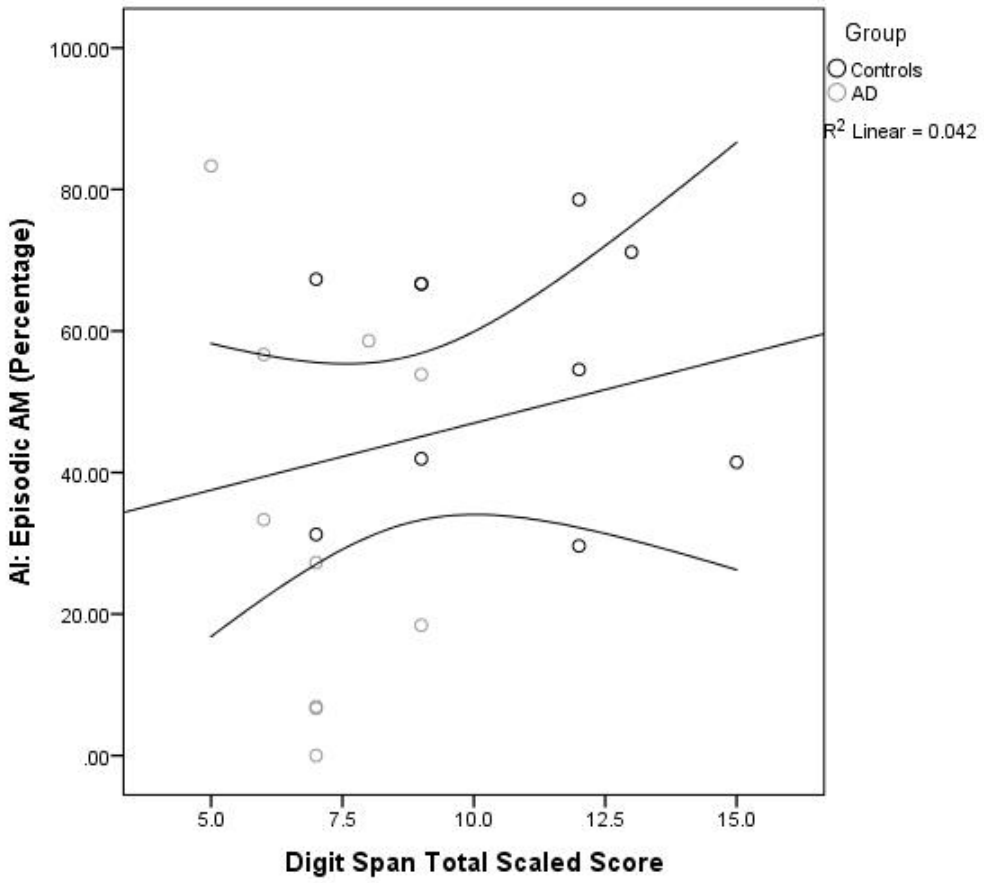

Group
Controls
AD
R2 Linear = 6.212E-4
VAF3 Total Events (<24 hours)
ACE-R Fluency Score /14

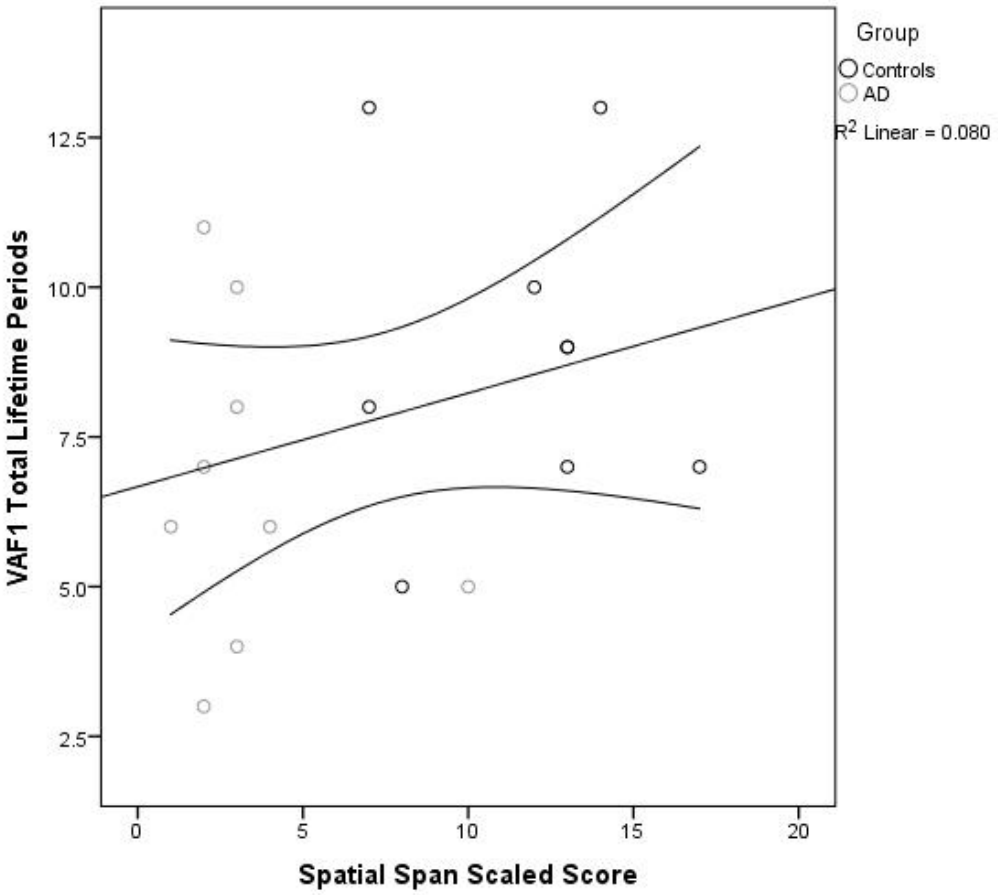

Group
Controls
AD
R2 Linear = 0.206
AI: Episodic AM (Percentage)
ACE-R Fluency Score /14

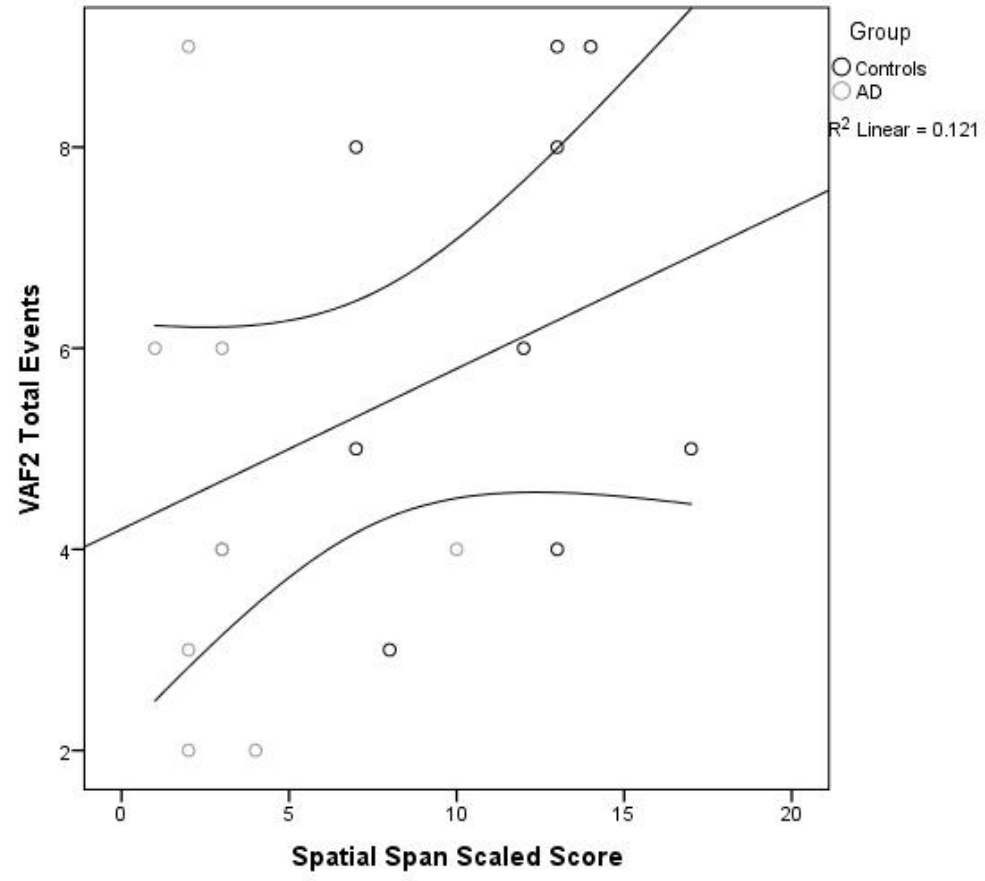

Group
Controls
AD
R2 Linear = 0.218
VAF1 Total Lifetime Periods
12.5
10.0
7.5
5.0
2.5
5.0
7.5
10.0
12.5
15.0
Digit Span Total Scaled Score

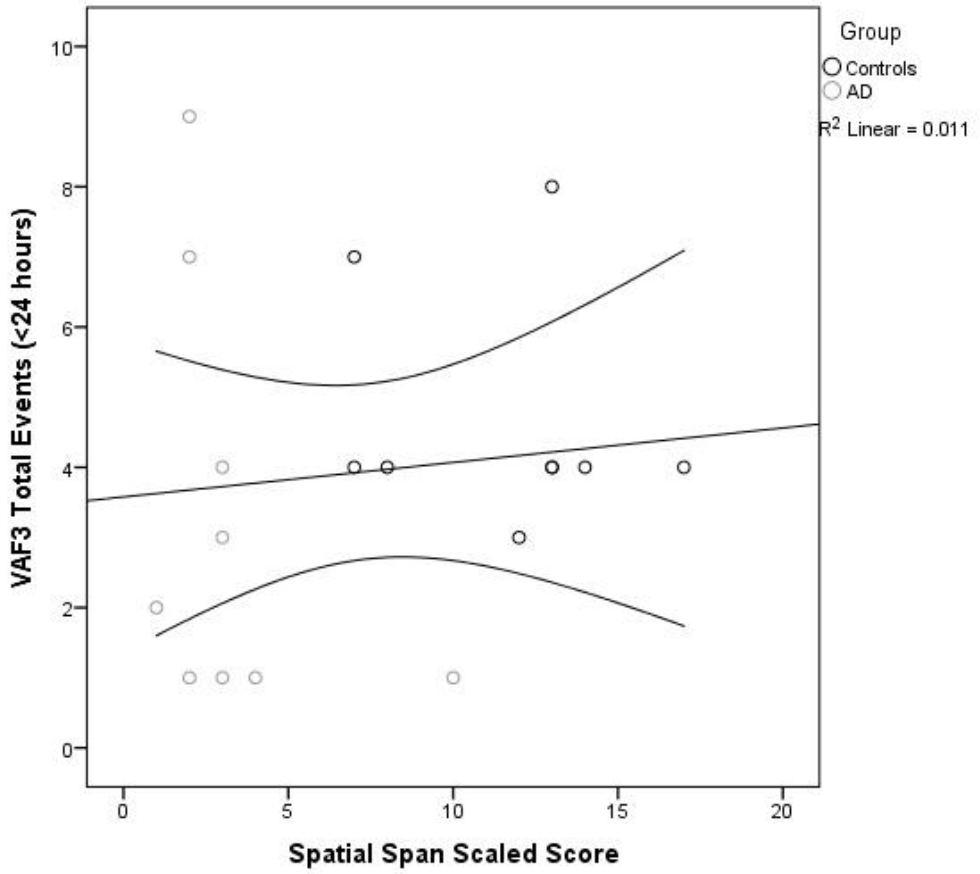

Group
Controls
AD
R2 Linear = 0.173
VAF2 Total Events
10
8
6
4
2
0
5.0
7.5
10.0
12.5
15.0
Digit Span Total Scaled Score

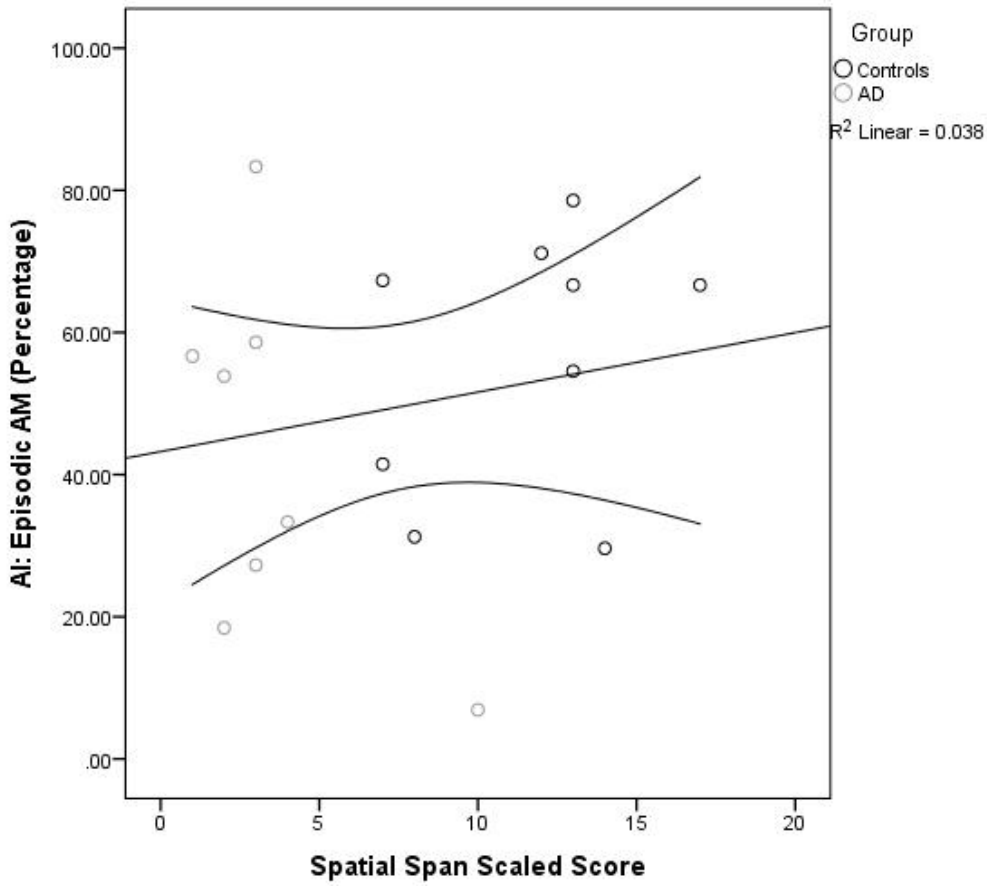

Group
Controls
AD
R^2 Linear = 0.129
VAF3 Total Events (<24 hours)
0
2
4
6
8
10
5.0
7.5
10.0
12.5
15.0
Digit Span Total Scaled Score

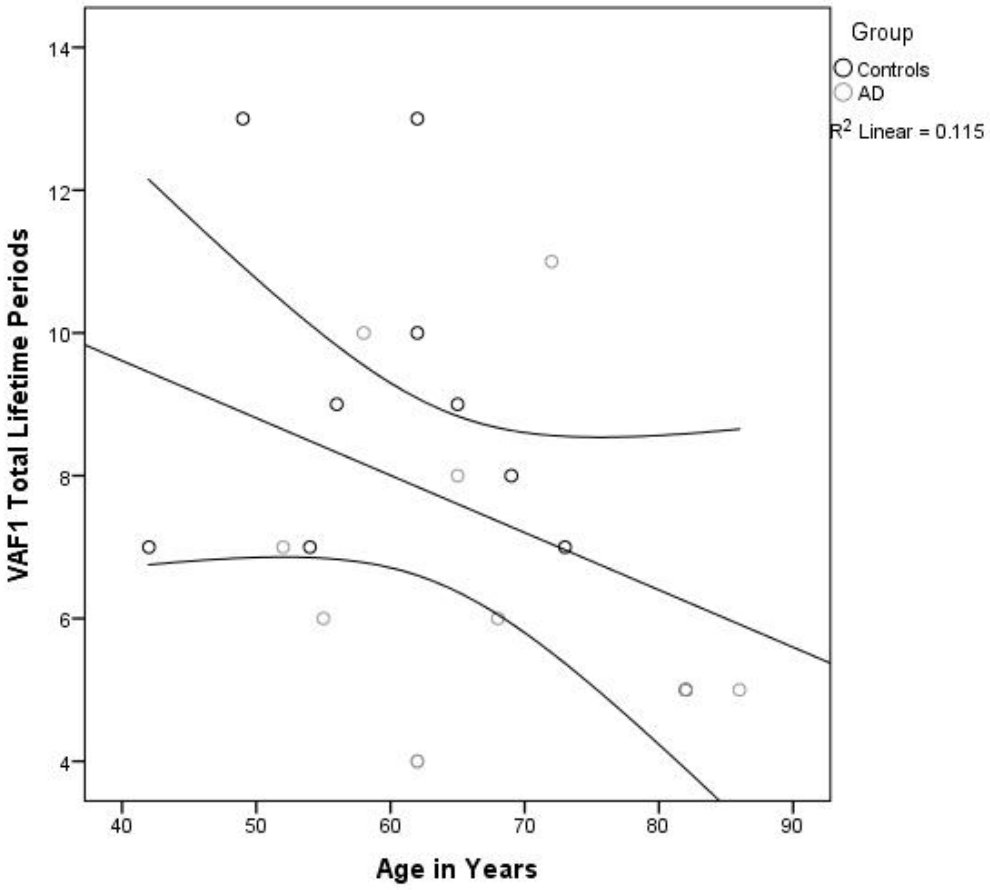

Group
Controls
AD
R^2 Linear = 0.042
AI: Episodic AM (Percentage)
.00
20.00
40.00
60.00
80.00
100.00
5.0
7.5
10.0
12.5
15.0
Digit Span Total Scaled Score

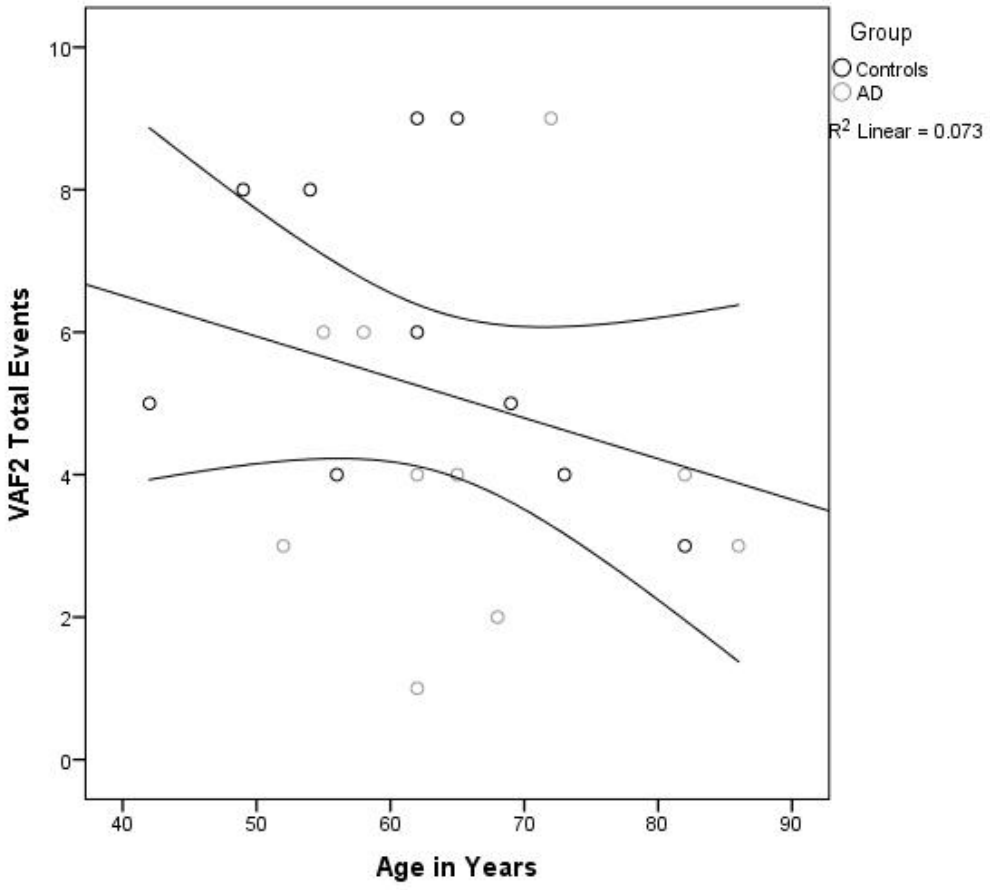

Group
Controls
AD
R2 Linear = 0.080
VAF1 Total Lifetime Periods
12.5
10.0
7.5
5.0
2.5
0
5
10
15
20
Spatial Span Scaled Score

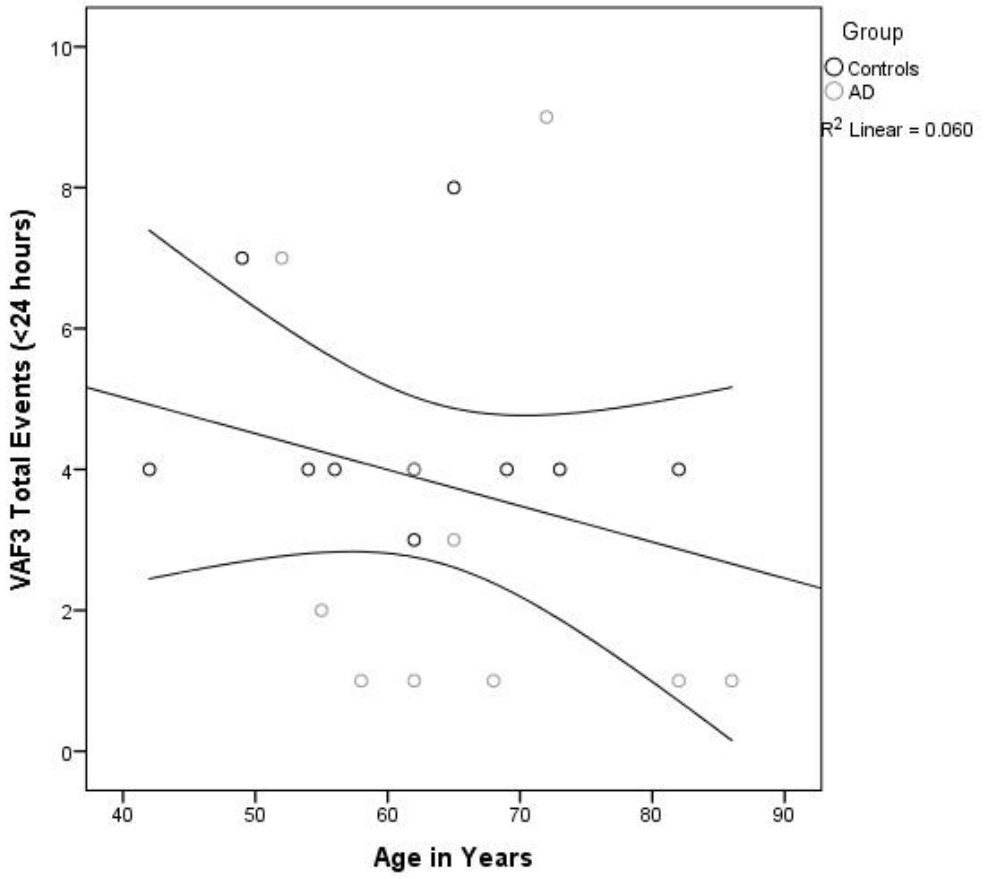

Group
Controls
AD
R2 Linear = 0.121
VAF2 Total Events
8
6
4
2
0
5
10
15
20
Spatial Span Scaled Score

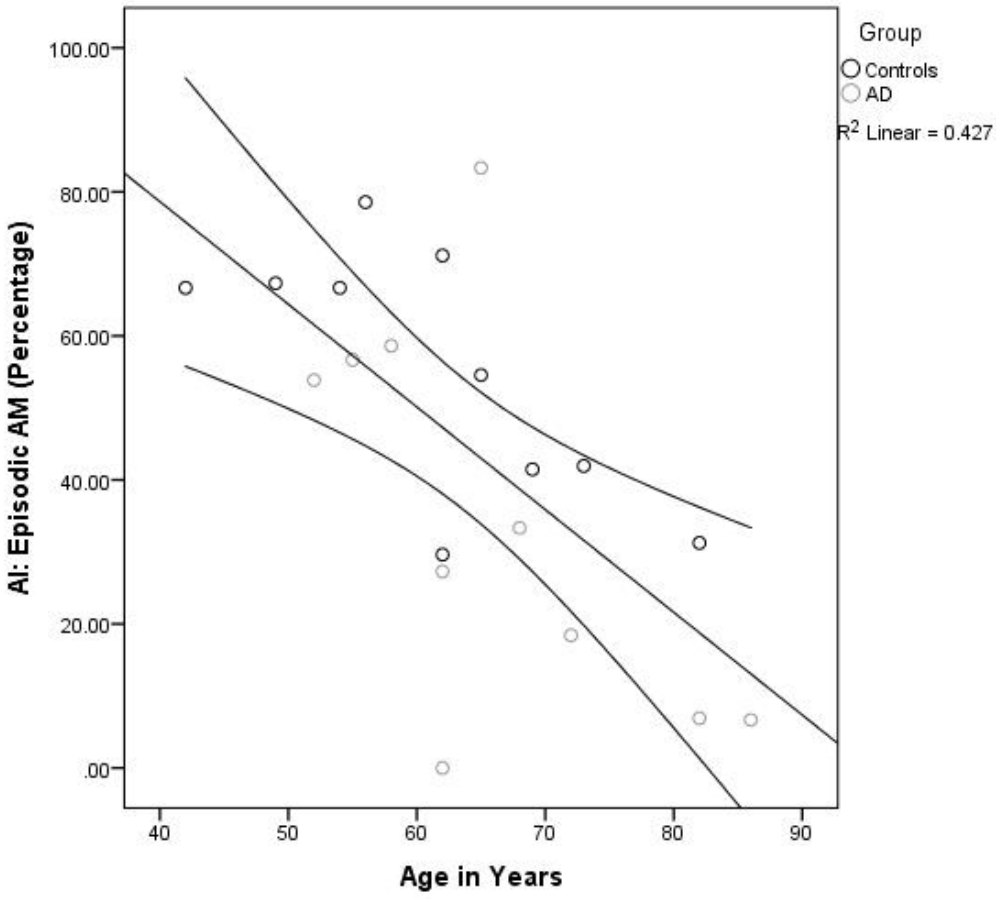

Group
Controls
AD
R^2 Linear = 0.011
VAF3 Total Events (<24 hours)
Spatial Span Scaled Score
0
2
4
6
8
10
0
5
10
15
20


Group
Controls
AD
R^2 Linear = 0.038
AI: Episodic AM (Percentage)
Spatial Span Scaled Score
.00
20.00
40.00
60.00
80.00
100.00
0
5
10
15
20


Group
Controls
AD
R2 Linear = 0.115
VAF1 Total Lifetime Periods
14
12
10
8
6
4
40
50
60
70
80
90
Age in Years

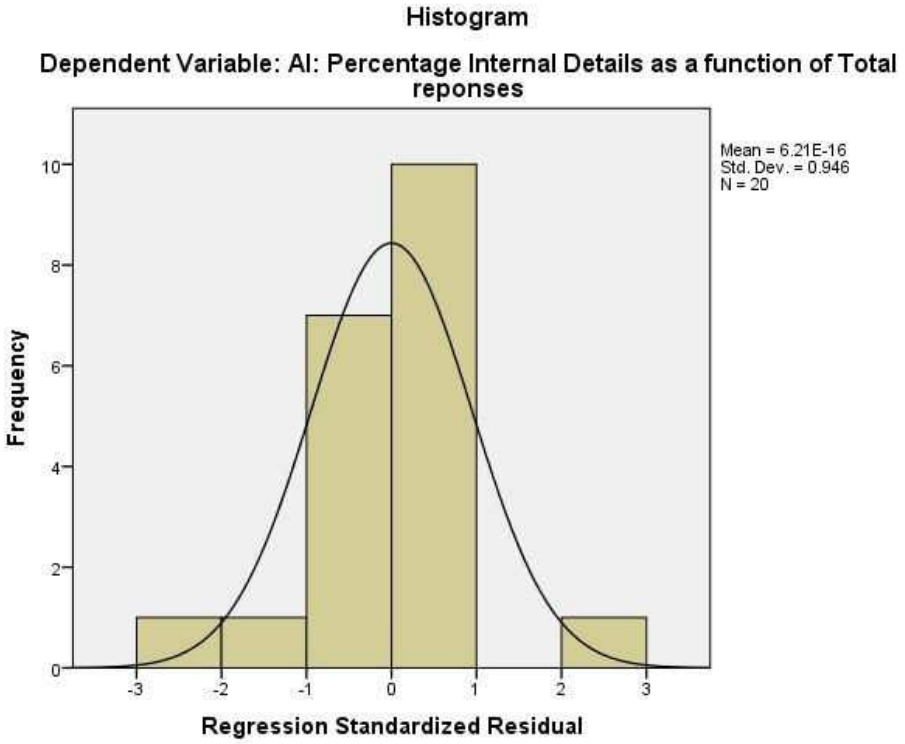

Group
Controls
AD
R2 Linear = 0.073
VAF2 Total Events
10
8
6
4
2
0
40
50
60
70
80
90
Age in Years

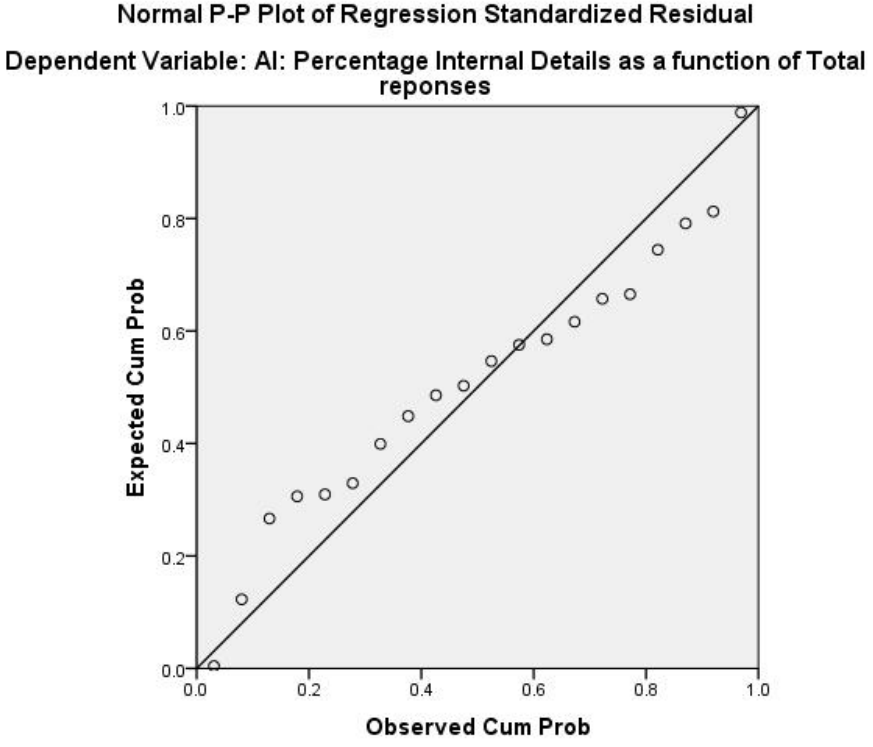

Group
Controls
AD
R^2 Linear = 0.060
VAF3 Total Events (<24 hours)
10
8
6
4
2
0
40
50
60
70
80
90
Age in Years


Group
Controls
AD
R^2 Linear = 0.427
AI: Episodic AM (Percentage)
100.00
80.00
60.00
40.00
20.00
.00
40
50
60
70
80
90
Age in Years

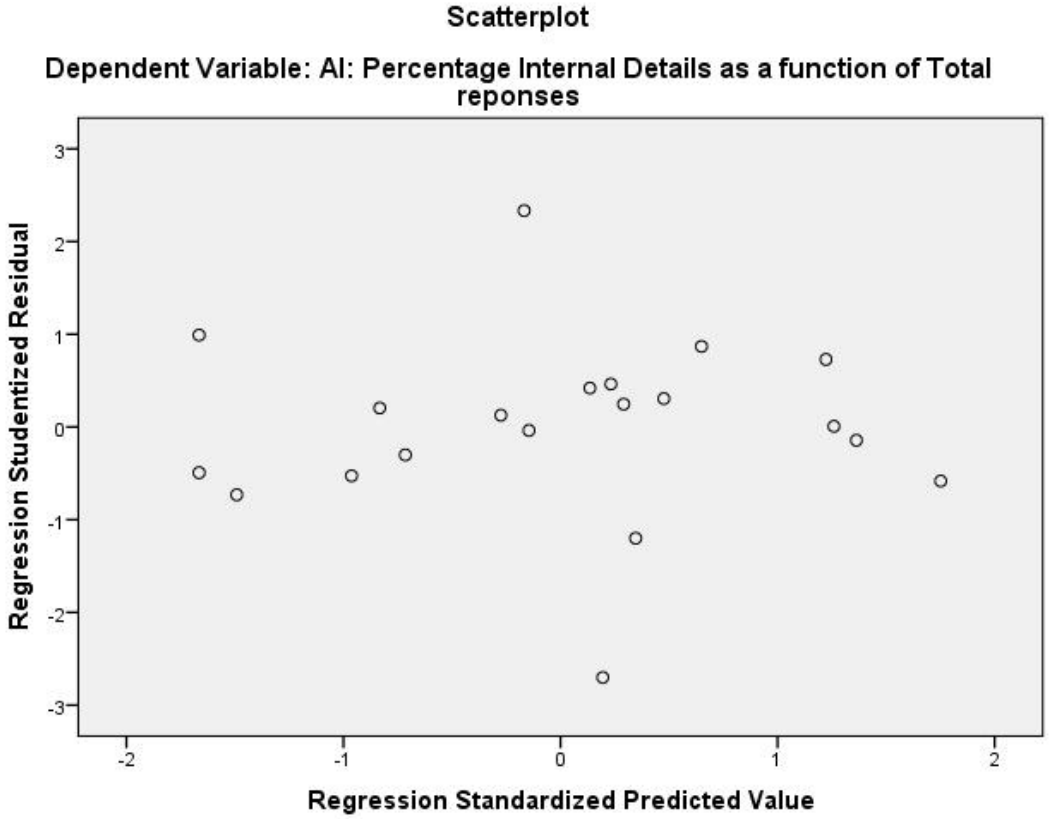
Appendix M

Tests of assumptions for linear regression





The histogram and P-P plot indicated that the regression data were normally distributed.



The *ZRESID against *ZPRED plot was indicative of homoscedasticity, thus meeting this assumption for linear regression.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6.441	18.416		.350	.731		
	ACE-R Fluency Score /14	4.008	1.853	.454	2.162	.044	1.000	1.000
2	(Constant)	98.873	31.790		3.110	.006		
	ACE-R Fluency Score /14	2.705	1.543	.307	1.753	.098	.934	1.071
	Age in Years	-1.254	.382	-.575	-3.287	.004	.934	1.071

a. Dependent Variable: AI: Percentage Internal Details as a function of Total reponses

VIF values less than 10 and the average not substantially greater than 1, indicating that the model met the assumption of multicollinearity

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.454[a]	.206	.162	22.76958	.206	4.676	1	18	.044	
2	.717[b]	.515	.458	18.32147	.308	10.801	1	17	.004	1.829

a. Predictors: (Constant), ACE-R Fluency Score /14

b. Predictors: (Constant), ACE-R Fluency Score /14, Age in Years

c. Dependent Variable: AI: Percentage Internal Details as a function of Total reponses

Durbin-Watson statistic close to 2, indicating that the residuals in the regression model are not correlated (independent), thus meeting this assumption for the regression analysis.

Appendix N

Participant Information Sheets

PARTICIPANT INFORMATION SHEET

Patient Version 2

Project Title: How do we remember our past? A memory research study.

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. **One of our team will go through the information sheet with you and answer any questions you have.**

Talk to others about the study if you wish.

Please do ask us if there is anything that is not clear.

What is the purpose of the study?
The ability to remember our past (autobiographical memory) plays an important part in determining what we think about ourselves and other people. Some people are able to remember more specific details about their past than others but we do not fully understand why this is. Therefore, we are investigating the thinking process involved in remembering past, specific events.

Why have I been invited to participate?
In order to investigate how we remember specific events, we need to ask people with a wide range of memory abilities to take part. You have been invited to participate because either you or someone you know has reported problems with memory.

Do I have to take part?
It is up to you to decide to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time, without giving a reason. This would not affect the standard of care you receive.

What will happen to me if I take part?
If you do decide to take part, you will be asked to meet once with the researcher to complete a series of tasks designed to assess types of thinking, including memory. This will take between 1 and 1.5 hours (one-and-a-half-hours). This can either be completed at the hospital or the researcher can visit you at home, whichever is more convenient.

This project does <u>not</u> involve any medical procedures and will not affect your medical care. It will involve answering some questions and some pencil and paper-based tasks.

If you have already completed any of these pencil and paper-based tasks as part of your routine clinical care in the past six months, we can use the results of these tasks instead of asking you to do them again. This will mean you spend less time doing the tasks with the

researcher. By agreeing to take part you also agree that your consultant can access your medical records and pass on the results to the researcher (they will not pass on any other information and the researcher will never have direct access to your medical records).

Any information you provide will be kept confidential without any information that could identify you. If you agree, some of the conversation with the researcher will be recorded so it can be transcribed at a later date. Once the conversation has been transcribed verbatim (word-for-word), the recording will be destroyed. The transcript will be anonymous and will not contain any identifying information. As the transcripts will be anonymous and verbatim, you will not be given a copy of the transcript to comment on.

We only ask that you try your best on the tasks. Once they have been completed, you will not need to meet with the researcher again.

Will you tell anyone that I am taking part?
It is useful for your GP to be aware of any health care research you are involved with. If you decide to take part, we will ask you for the name and address of your GP, and write a short letter to give them details of the research and let them know that you are participating.

What are the possible risks and disadvantages of taking part?
There are no immediate risks involved in this study. You may find that you become tired because the tasks involve concentrating for a sustained period. There is also a possibility that some tasks might frustrate you if you find them tricky. However it is important to remember that the tasks are designed to be tricky and that we only ask you do the best you can.

What are the possible benefits of taking part?
Taking part in this research will help us to understand memory in more detail. We hope to use the information we gather from this research to find more helpful ways of detecting memory problems, and to think of new ways we can lower distress caused by memory difficulties. Although we hope you enjoy taking part, we cannot promise that you will experience any direct benefit yourself.

What if there is a problem?
If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions. In the first instance, please contact Dr. Fergal Jones, Senior Lecturer and Clinical Psychologist, Department of Applied Psychology, Canterbury Christ Church University (email: fergal.jones@canterbury.ac.uk, or telephone: 01892 507 636).

If you remain unhappy and wish to complain formally, you can do this via the Canterbury Christ Church University's Department of Applied Psychology complaints procedures. Please contact Professor Paul Camic on 01892 507 773, or paul.camic@canterbury.ac.uk.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence. All written information you provide will be anonymous and will not be kept with any information that could identify you. All our data will be kept on a password-protected data holding device while the research project is being carried out. Once the

project is complete, the anonymous data will be kept on a password-protected CD in a locked cabinet in the Department of Applied Psychology, Canterbury Christ Church University, for 10 years after which time it will be destroyed.

What if the researcher is worried about me?
The researcher has a duty of care towards you whilst you are participating. Although extremely rare, if the researcher is worried that you are at risk of harm, or that there is a risk that you may harm other people, they have a duty to contact your health-care professional to inform them. Therefore, if the researcher has any concerns about your health, if you are particularly worried or sad during participation, or you express a wish to harm others, they will contact your GP and hospital consultant to let them know. This will be discussed with you at the time of participation.

What will happen if I don't want to carry on with the study?
You are free to withdraw from the study at any time, without consequence. Withdrawing from the research will not affect your medical care. Any information that has already been collected about you for the purposes of this study will be destroyed.

What will happen to the results of the research study?
We hope to publish the results of this study in a scientific journal. Any publications resulting from this project will not contain any identifying information. If you would like us to write to you with a summary of the findings once the research is complete, which will be September 2013, please contact the researcher at m.j.benjamin72@canterbury.ac.uk, or call 01892 507 673.

Who is organising and funding this research?
This project is being conducted as part of the researcher's professional doctorate award necessary to qualify as a clinical psychologist. The researcher is based at the Department of Applied Psychology, Salomons Campus, Canterbury Christ Church University. The project is funded by the University. It is being conducted in collaboration with other institutions with a specialist interest in dementia and memory research.

Who has reviewed this study?
All research in the NHS is looked at by independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by the London - Westminster Research Ethics Committee on 04/05/12 (reference number: 12/LO/0447). It has also been independently reviewed by senior staff at Canterbury Christ Church University who are not directly associated with this project.

Further information and contact details
If you have any further questions please do not hesitate to contact the researcher by emailing m.j.benjamin72@canterbury.ac.uk or calling 01892 507 673. Alternatively you can write to:

Max Benjamin, Trainee Clinical Psychologist
Department of Applied Psychology,
Canterbury Christ Church University,
Salomons Campus, Broomhill Road,
Tunbridge Wells, Kent,
TN3 0TG

PARTICIPANT INFORMATION SHEET

Control Version 2

Project Title: How do we remember our past? A memory research study.

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. **One of our team will go through the information sheet with you and answer any questions you have.**

Talk to others about the study if you wish.

Please do ask us if there is anything that is not clear.

What is the purpose of the study?
The ability to remember our past (autobiographical memory) plays an important part in determining what we think about ourselves and other people. Some people are able to remember more specific details about their past than others but we do not fully understand why this is. Therefore, we are investigating the thinking process involved in remembering past, specific events.

Why have I been invited to participate?
In order to investigate how we remember specific events, we need to ask people with a wide range of memory abilities to take part. You have been contacted because you know someone who is being seen at hospital for memory problems, and you have been invited to participate because you are of a similar age to people with Alzheimer's Disease.

Do I have to take part?
It is up to you to decide to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time, without giving a reason and without consequence.

What will happen to me if I take part?
If you do decide to take part, you will be asked to meet once with the researcher to complete a series of tasks designed to assess types of thinking, including memory. This will take between 1 and 1.5 hours (one-and-a-half-hours). This can either be completed at the hospital or the researcher can visit you at home, whichever is more convenient.

This project does not involve any medical procedures. It will involve answering some questions and some pencil and paper-based tasks. Any information you provide will be kept confidential without any information that could identify you. If you agree, some of the conversation with the researcher will be recorded so it can be transcribed at a later date. Once the conversation has been transcribed verbatim (word-for-word), the recording will be destroyed. The transcript will be anonymous and will not contain any identifying

information. As the transcripts will be anonymous and verbatim, you will not be given a copy of the transcript to comment on.

We only ask that you try your best on the tasks. Once they have been completed, you will not need to meet with the researcher again.

What are the possible risks and disadvantages of taking part?
There are no immediate risks involved in this study. You may find that you become tired because the tasks involve concentrating for a sustained period. There is also a possibility that some tasks might frustrate you if you find them tricky. However it is important to remember that the tasks are designed to be tricky and that we only ask you do the best you can.

What are the possible benefits of taking part?
Taking part in this research will help us to understand memory in more detail. We hope to use the information we gather from this research to find more helpful ways of detecting memory problems, and to think of new ways we can lower distress caused by memory difficulties. Although we hope you enjoy taking part, we cannot promise that you will experience any direct benefit yourself.

What if there is a problem?
If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions. In the first instance, please contact Dr. Fergal Jones, Senior Lecturer and Clinical Psychologist, Department of Applied Psychology, Canterbury Christ Church University (email: fergal.jones@canterbury.ac.uk, or telephone: 01892 507 636).

If you remain unhappy and wish to complain formally, you can do this via the Canterbury Christ Church University's Department of Applied Psychology complaints procedures. Please contact Professor Paul Camic on 01892 507 773, or paul.camic@canterbury.ac.uk.

Will my taking part in the study be kept confidential?
Yes. We will follow ethical and legal practice and all information about you will be handled in confidence. All written information you provide will be anonymous and will not be kept with any information that could identify you. All our data will be kept on a password-protected data holding device while the research project is being carried out. Once the project is complete, the anonymous data will be kept on a password-protected CD in a locked cabinet in the Department of Applied Psychology, Canterbury Christ Church University, for 10 years after which time it will be destroyed.

What if the researcher is worried about me?
The researcher has a duty of care towards you whilst you are participating. Although extremely rare, if the researcher is worried that you are at risk of harm, or that there is a risk that you may harm other people, they have a duty to contact your health-care

professional to inform them. Therefore, if the researcher has any concerns about your health, if you are particularly worried or sad during participation, or you express a wish to harm others, they will ask you for details of your GP in order to let them know. By agreeing to participate, you agree to provide the researcher with details of your GP at the beginning of your participation. This will be discussed with you at the time of participation.

What will happen if I don't want to carry on with the study?
You are free to withdraw from the study at any time, without consequence. Any information that has already been collected about you for the purposes of this study will be destroyed.

What will happen to the results of the research study?
We hope to publish the results of this study in a scientific journal. Any publications resulting from this project will not contain any identifying information. If you would like us to write to you with a summary of the findings once the research is complete, which will be September 2013, please contact the researcher at m.j.benjamin72@canterbury.ac.uk, or call 01892 507 673.

Who is organising and funding this research?
This project is being conducted as part of the researcher's professional doctorate award necessary to qualify as a clinical psychologist. The researcher is based at the Department of Applied Psychology, Salomons Campus, Canterbury Christ Church University. The project is funded by the University. It is being conducted in collaboration with other institutions with a specialist interest in dementia and memory research.

Who has reviewed this study?
All research in the NHS is looked at by independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by the London - Westminster Research Ethics Committee on 04/05/12 (reference number: 12/LO/0447). It has also been independently reviewed by senior staff at Canterbury Christ Church University who are not directly associated with this project.

Further information and contact details
If you have any further questions please do not hesitate to contact the researcher by emailing m.j.benjamin72@canterbury.ac.uk or calling 01892 507 673. Alternatively you can write to:

Max Benjamin, Trainee Clinical Psychologist,
Department of Applied Psychology,
Canterbury Christ Church University,
Salomons Campus, Broomhill Road,
Tunbridge Wells, Kent,
TN3 0TG.

INFORMATION SHEET FOR HEALTH-CARE PROFESSIONALS OF PARTICIPANTS

Version 2

Project Title: How do we remember our past? A memory research study.

We are writing to you to inform you that your patient/client, _____ has agreed to participate in the above research project. Please find details of the study below. If you have any further questions please do not hesitate to contact the researchers using the contact details on the last page.

What is the purpose of the study?

The ability to remember our past (autobiographical memory) plays an important part in determining what we think about ourselves and other people. Some people are able to remember more specific details about their past than others but we do not fully understand why this is. Therefore, we are investigating the thinking process involved in remembering past, specific events.

Why has my patient/client been invited to participate?

In order to investigate how we remember specific events, we need to ask people with a wide range of memory abilities to take part. Your patient/client has been invited to participate because either they or someone they know has reported problems with memory.

What does participation involve?

Participants will be asked to meet once with the researcher to complete a series of tasks designed to assess types of thinking, including memory. This will take between 1 and 1.5 hours (one-and-a-half-hours). This can either be completed at the hospital or the researcher can visit participants at home, whichever is more convenient.

This project does <u>not</u> involve any medical procedures and will not affect participants' medical care. It will involve answering some questions and some pencil and paper-based tasks.

If participants have already completed any of these pencil and paper-based tasks as part of routine clinical care in the past six months, we can use the results of these tasks instead of asking them to repeat the tasks. This will mean they spend less time doing the tasks with the researcher. By agreeing to take part they also agree that their consultant can access their medical records and pass on the results to the researcher (they will not pass on any other information and the researcher will never have direct access to medical records).

Any information provided will be kept confidential without any information that could identify the participant. If they agree, some of the conversation with the researcher will be recorded so it can be transcribed at a later date. Once the conversation has been transcribed verbatim (word-for-word), the recording will be destroyed. The transcript will be anonymous and will not contain any identifying information. Participants will not be given a copy of the transcript.

We only ask that participants try their best on the tasks. Once they have been completed, they will not need to meet with the researcher again.

What are the possible risks and disadvantages of taking part?
There are no immediate risks involved in this study. Participants may find that they become tired because the tasks involve concentrating for a sustained period. There is also a possibility that some tasks might frustrate participants if they find them tricky. However it is important to remember that the tasks are designed to be tricky and that we only ask participants do the best they can.

What are the possible benefits of taking part?
Taking part in this research will help us to understand memory in more detail. We hope to use the information we gather from this research to find more helpful ways of detecting memory problems, and to think of new ways we can lower distress caused by memory difficulties. Although we hope participants enjoy taking part, we cannot promise that they will experience any direct benefit.

What if the researcher is worried about my patient/client?
The researcher has a duty of care towards participants. If the researcher has any concerns about their health or safety, if they are particularly worried or sad during participation, or that a participant may be a risk to others, they will contact you to ask for appropriate follow-up. Your patient/client has agreed to provide your details as a condition of participation.

What will happen if my patient/client does not want to carry on with the study?
Participants are free to withdraw from the study at any time, without consequence. Withdrawing from the research will not affect their medical care. Any information that has already been collected for the purposes of this study will be destroyed.

What will happen to the results of the research study?
We hope to publish the results of this study in a scientific journal. Any publications resulting from this project will not contain any identifying information.

Who is organising and funding this research?
This project is being conducted as part of the researcher's professional doctorate award necessary to qualify as a clinical psychologist. The researcher is based at the Department of Applied Psychology, Salomons Campus, Canterbury Christ Church University. The project is

funded by the University. It is being conducted in collaboration with other institutions with a specialist interest in dementia and memory research.

Who has reviewed this study?

All research in the NHS is looked at by independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by the London - Westminster Research Ethics Committee on 04/05/12 (reference number: 12/LO/0447). It has also been independently reviewed by senior staff at Canterbury Christ Church University who are not directly associated with this project.

Further information and contact details

If you have any further questions please do not hesitate to contact the researcher by emailing m.j.benjamin72@canterbury.ac.uk or calling 01892 507 673. Alternatively you can write to:

Max Benjamin, Trainee Clinical Psychologist,
Department of Applied Psychology,
Canterbury Christ Church University,
Salomons Campus,
Broomhill Road,
Tunbridge Wells,
Kent,
TN3 0TG.

Appendix O

Participant Consent Forms

RESEARCH CONSENT FORM

Patient Version 2

Title of Project:

How do we remember our past? A memory research study

Name of Researcher: Max Benjamin, Trainee Clinical Psychologist

Please initial box

1. I confirm that I have read and understand the information sheet dated 21/04/12 (version 2) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant sections of my medical notes and data collected during the study, may be looked at by individuals from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I agree to give the researcher details of my GP and for my GP to be informed about my participation, and subsequently informed if any concerns arise. ☐

5. I agree to take part in the above study. ☐

_____	_____	_____
Name of Participant	Date	Signature
_____	_____	_____
Name of Person taking consent	Date	Signature

RESEARCH CONSENT FORM

Control Version 2

Title of Project:

How do we remember our past? A memory research study

Name of Researcher: Max Benjamin, Trainee Clinical Psychologist

Please initial box

1. I confirm that I have read and understand the information sheet dated 21/04/12 (version 2) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, and without consequence. ☐

3. I agree to give the researcher details of my GP and for my GP to be informed if any medical indications are found as a result of my participation. ☐

4. I agree to take part in the above study. ☐

_____	_____	_____
Name of Participant	Date	Signature
_____	_____	_____
Name of Person taking consent	Date	Signature

PARTICIPANT ID:_____ DATE:_____

Appendix P

Verbal Autobiographical Fluency task record form

Hierarchical Verbal Autobiographical Fluency Task

(Piolino et al., 2010)

Record Sheet

Instructions

I will ask you to recall some memories about yourself, to remember memories from your own life. You will recall events you experienced and information about them. You should be involved in the memories you evoke.

We will start with very general events that lasted a long time, and then go on to very specific and detailed events corresponding to very short moments of your life you can re-experience, like a "zoom".

Take care! This is a four-stage task: at each stage, you will be given a limited amount of time to list events. Try to create response lists according to the given criterion. When the time is up, we will review each item you listed and ask for more information. For each stage, I'll give you examples.

VAF 1

In our life, there are periods that last several years; they have a (very) long duration.

Examples: *The lifetime period of "primary school"; living in "Blue Street"; living with "Paul"; the "first job", etc.*

-Can you list any periods of your life that lasted for several (at least 3) years?

-These periods can overlap (e.g. living in "Blue Street" could overlap with "going to high school").

-For each period, could you also tell me whether you are remembering it by "mentally seeing it in your mind's eye", as if you were "travelling back in time" in order to relive it; or whether you are recalling it as something you "just know" happened?

-Could you also indicate whether you are remembering something as if you were there, through you own eyes, or whether you are remembering it as a scene you are observing, as if you were there with a video camera or "a fly on the wall"?

-You have 2 minutes to give me as many lifetime periods as you can. READY? GO!

	[R/K] [F/O/FO]		**[R/K] [F/O/FO]**		**[R/K] [F/O/FO]**
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	

PARTICIPANT ID:_____ DATE:_____

VAF 2

During any given period, there are things we do regularly.

Examples: *If I choose the period "living in Blue Street": dance lessons, country weekends, family Christmas, parties with high school friends, etc.*

There are also things that last for a relatively long time (several days, or weeks), but that have a shorter duration than periods of life.

Examples: *If I choose the period "Living in Blue Street": holidays in Italy, pottery courses, season job during the grape harvest, etc.*

-Try to choose the most prominent period of your life from those you previously mentioned (VAF 1), the one for which you can give the most events of the types I just described to you, and the one for which your memories are the clearest and most detailed.

Choice of life-period: _____

-In the period you chose, can you list some events that lasted between a few days and a few weeks (repeated or not), or things that you did regularly?

-For each event, could you also tell me whether you are remembering it by "mentally seeing it in your mind's eye", as if you were "travelling back in time" in order to relive it; or whether you are recalling it as something you "just know" happened?

-Could you also indicate whether you are remembering something as if you were there, through you own eyes, or whether you are remembering it as a scene you are observing, as if you were there with a video camera or "a fly on the wall"?

-You have 2 minutes to give me as many general events as you can. READY? GO!

	[R/K] [F/O/FO]		**[R/K] [F/O/FO]**		**[R/K] [F/O/FO]**
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	

PARTICIPANT ID:_____ DATE:_____

VAF 3

For each of these events we can remember a particular time, some hours long, which lasted less than a day.

Examples: *In the example of "parties with high school friends": "Anna's 18th birthday"; "Remy's wedding"; "the theatre show", etc.*

-Try to choose the most prominent event from those you previously mentioned (VAF 2), the one for which you can give the most specific events of the types I just described to you, the one for which your memories are the clearest and most detailed.

Choice of event:_____

-In the event you chose, can you name some events that lasted for a few hours, less than 24 hours? These events don't last more than a day, and have to be unique, never repeated.

-For each event, could you also tell me whether you are remembering it by "mentally seeing it in your mind's eye", as if you were "travelling back in time" in order to relive it; or whether you are recalling it as something you "just know" happened?

-Could you also indicate whether you are remembering something as if you were there, through you own eyes, or whether you are remembering it as a scene you are observing, as if you were there with a video camera or "a fly on the wall"?

-You have 2 minutes to give me as many specific events as you can. READY? GO

	[R/K] [F/O/FO]		**[R/K] [F/O/FO]**		**[R/K] [F/O/FO]**
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	
_____		_____		_____	

PARTICIPANT ID:_____ DATE:_____

<u>VAF 4</u> [to be digitally recorded]

For one particular event, we may remember very clear details, things that lasted a few seconds, no more than a few minutes.

Examples: *In the example of "Anna's birthday party": "the cake fell over and Suzanne screamed, the smell of the caramel, the surprise when Paul and Barbara arrived", etc.*

-Try to choose the most prominent event from those you previously mentioned (VAF 3), the one for which you can give the most events of the types I just described to you, the one for which your memory is the clearest and most detailed.

Choice of event: _____

-Could you try to give as much information and as many details as possible about this moment you can re-experience mentally? Perceptual and sensory information: images, colours, smells, sounds, sensations, temperature, hour, place, actions, others, etc. Details that lasted a few seconds or minutes at the most?

-You have 2 minutes to give me as many details as you can. READY? GO!

Record response and write any notes here:

That's the end of this task. Thank you very much for doing all of it.

Appendix Q

This has been removed from the electronic copy

Appendix R

Neuropsycholgia author guidelines for preparation of manuscripts

Preparation

The following article types are accepted:

(a) Research Reports
(up to 20 printed journal pages or about 17,000 words)

(b)Reviews and Perspectives
(up to 30 printed journal pages or 26,000 words). These should also provide critical accounts and comprehensive surveys of topics of major current interest within the scope of the journal.

NEW SUBMISSIONS

Submission to this journal proceeds totally online and you will be guided stepwise through the creation and uploading of your files. The system automatically converts your files to a single PDF file, which is used in the peer-review process.
As part of the Your Paper Your Way service, you may choose to submit your manuscript as a single file to be used in the refereeing process. This can be a PDF file or a Word document, in any format or lay-out that can be used by referees to evaluate your manuscript. It should contain high enough quality figures for refereeing. If you prefer to do so, you may still provide all or some of the source files at the initial submission. Please note that individual figure files larger than 10 MB must be uploaded separately.

References

There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/book title, chapter title/article title, year of publication, volume number/book chapter and the pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be highlighted at proof stage for the author to correct.

Formatting requirements

There are no strict formatting requirements but all manuscripts must contain the essential elements needed to convey your manuscript, for example Abstract, Keywords, Introduction, Materials and Methods, Results, Conclusions, Artwork and Tables with Captions.
If your article includes any Videos and/or other Supplementary material, this should be included in your initial submission for peer review purposes.
Divide the article into clearly defined sections.

Figures and tables embedded in text
If you choose to use our Your Paper Your Way service, please ensure the figures and the tables included in the single file are placed next to the relevant text in the manuscript, rather than at the bottom or the top of the file.

REVISED SUBMISSIONS

Use of wordprocessing software

Regardless of the file format of the original submission, at revision you must provide us with an editable file of the entire article. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier: http://www.elsevier.com/guidepublication). See also the section on Electronic artwork.
To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your wordprocessor.

Article structure

Subdivision - numbered sections

Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, ...), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to 'the text'. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

Results

Results should be clear and concise.

Discussion

This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Appendices

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

• **Title.** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• **Author names and affiliations.** Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter

immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• **Corresponding author.** Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. **Ensure that phone numbers (with country and area code) are provided in addition to the e-mail address and the complete postal address. Contact details must be kept up to date by the corresponding author.**
• **Present/permanent address.** If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract

A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Graphical abstract

A Graphical abstract is optional and should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership online. Authors must provide images that clearly represent the work described in the article. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. See http://www.elsevier.com/graphicalabstracts for examples.
Authors can make use of Elsevier's Illustration and Enhancement service to ensure the best presentation of their images also in accordance with all technical requirements: Illustration Service.

Highlights

Highlights are mandatory for this journal. They consist of a short collection of bullet points that convey the core findings of the article and should be submitted in a separate file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point). See http://www.elsevier.com/highlights for examples.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using British spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Database linking

Elsevier encourages authors to connect articles with external databases, giving their readers one-click access to relevant databases that help to build a better understanding of the described research. Please refer to relevant database identifiers using the following format in your article: Database: xxxx (e.g., TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN). See http://www.elsevier.com/databaselinking for more information and a full list of supported databases.

Footnotes

Footnotes should be used sparingly. Number them consecutively throughout the article. Many wordprocessors build footnotes into the text, and this feature may be used. Should this not be the case, indicate the position of footnotes in the text and present the footnotes themselves separately at the end of the article. Do not include footnotes in the Reference list.
Table footnotes
Indicate each footnote in a table with a superscript lowercase letter.

Artwork

Electronic artwork
General points
• Make sure you use uniform lettering and sizing of your original artwork.
• Preferred fonts: Arial (or Helvetica), Times New Roman (or Times), Symbol, Courier.
• Number the illustrations according to their sequence in the text.
• Use a logical naming convention for your artwork files.
• Indicate per figure if it is a single, 1.5 or 2-column fitting image.
• For Word submissions only, you may still provide figures and their captions, and tables within a single file at the revision stage.
• Please note that individual figure files larger than 10 MB must be provided in separate source files.
A detailed guide on electronic artwork is available on our website:
http://www.elsevier.com/artworkinstructions.
You are urged to visit this site; some excerpts from the detailed information are given here.
Formats
Regardless of the application used, when your electronic artwork is finalized, please 'save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):
EPS (or PDF): Vector drawings. Embed the font or save the text as 'graphics'.
TIFF (or JPG): Color or grayscale photographs (halftones): always use a minimum of 300 dpi.
TIFF (or JPG): Bitmapped line drawings: use a minimum of 1000 dpi.

TIFF (or JPG): Combinations bitmapped line/half-tone (color or grayscale): a minimum of 500 dpi is required.
Please do not:
• Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); the resolution is too low.
• Supply files that are too low in resolution.
• Submit graphics that are disproportionately large for the content.

Color artwork
Please make sure that artwork files are in an acceptable format (TIFF (or JPEG), EPS (or PDF), or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then Elsevier will ensure, at no additional charge, that these figures will appear in color on the Web (e.g., ScienceDirect and other sites) regardless of whether or not these illustrations are reproduced in color in the printed version. **For color reproduction in print, you will receive information regarding the costs from Elsevier after receipt of your accepted article.** Please indicate your preference for color: in print or on the Web only. For further information on the preparation of electronic artwork, please see http://www.elsevier.com/artworkinstructions.
Please note: Because of technical complications which can arise by converting color figures to 'gray scale' (for the printed version should you not opt for color in print) please submit in addition usable black and white versions of all the color illustrations.

Figure captions
Ensure that each illustration has a caption. A caption should comprise a brief title (**not** on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

Tables

Number tables consecutively in accordance with their appearance in the text. Place footnotes to tables below the table body and indicate them with superscript lowercase letters. Avoid vertical rules. Be sparing in the use of tables and ensure that the data presented in tables do not duplicate results described elsewhere in the article.

References

Citation in text
Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

Web references
As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

References in a special issue
Please ensure that the words 'this issue' are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

Reference style
Text: Citations in the text should follow the referencing style used by the American Psychological Association. You are referred to the Publication Manual of the American Psychological Association, Sixth Edition, ISBN 978-1-4338-0561-5, copies of which may be ordered from http://books.apa.org/books.cfm?id=4200067 or APA Order Dept., P.O.B. 2710, Hyattsville, MD 20784, USA or APA, 3 Henrietta Street, London, WC3E 8LU, UK.
List: references should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters 'a', 'b', 'c', etc., placed after the year of publication.
Examples:
Reference to a journal publication:
Van der Geer, J., Hanraads, J. A. J., & Lupton, R. A. (2010). The art of writing a scientific article. Journal of Scientific Communications, 163, 51–59.
Reference to a book:
Strunk, W., Jr., & White, E. B. (2000). The elements of style. (4th ed.). New York: Longman, (Chapter 4).
Reference to a chapter in an edited book:
Mettam, G. R., & Adams, L. B. (2009). How to prepare an electronic version of your article. In B. S. Jones, & R. Z. Smith (Eds.), Introduction to the electronic age (pp. 281–304). New York: E-Publishing Inc.

Video data

Elsevier accepts video material and animation sequences to support and enhance your scientific research. Authors who have video or animation files that they wish to submit with their article are strongly encouraged to include links to these within the body of the article. This can be done in the same way as a figure or table by referring to the video or animation content and noting in the body text where it should be placed. All submitted files should be properly labeled so that they directly relate to the video file's content. In order to ensure that your video or animation material is directly usable, please provide the files in one of our recommended file formats with a preferred maximum size of 50 MB. Video and animation files supplied will be published online in the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com. Please supply 'stills' with your files: you can choose any frame from the video or animation or make a separate image. These will be used instead of standard icons and will personalize the link to your video data. For more detailed instructions please visit our video instruction pages at http://www.elsevier.com/artworkinstructions. Note: since video and animation cannot be embedded in the print version of the journal, please provide text for both the electronic and the print version for the portions of the article that refer to this content.

AudioSlides

The journal encourages authors to create an AudioSlides presentation with their published article. AudioSlides are brief, webinar-style presentations that are shown next to the online article on ScienceDirect. This gives authors the opportunity to summarize their research in their own words and to help readers understand what the paper is about. More information

and examples are available at http://www.elsevier.com/audioslides. Authors of this journal will automatically receive an invitation e-mail to create an AudioSlides presentation after acceptance of their paper.

Supplementary data

Elsevier accepts electronic supplementary material to support and enhance your scientific research. Supplementary files offer the author additional possibilities to publish supporting applications, high-resolution images, background datasets, sound clips and more. Supplementary files supplied will be published online alongside the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com. In order to ensure that your submitted material is directly usable, please provide the data in one of our recommended file formats. Authors should submit the material in electronic format together with the article and supply a concise and descriptive caption for each file. For more detailed instructions please visit our artwork instruction pages at http://www.elsevier.com/artworkinstructions.

3D neuroimaging

You can enrich your online articles by providing 3D neuroimaging data in NIfTI format. This will be visualized for readers using the interactive viewer embedded within your article, and will enable them to: browse through available neuroimaging datasets; zoom, rotate and pan the 3D brain reconstruction; cut through the volume; change opacity and color mapping; switch between 3D and 2D projected views; and download the data. The viewer supports both single (.nii) and dual (.hdr and .img) NIfTI file formats. Recommended size of a single uncompressed dataset is 100 MB or less. Multiple datasets can be submitted. Each dataset will have to be zipped and uploaded to the online submission system via the '3D neuroimaging data' submission category. Please provide a short informative description for each dataset by filling in the 'Description' field when uploading a dataset. Note: all datasets will be available for downloading from the online article on ScienceDirect. If you have concerns about your data being downloadable, please provide a video instead. For more information see: http://www.elsevier.com/3DNeuroimaging.

Submission checklist

The following list will be useful during the final checking of an article prior to sending it to the journal for review. Please consult this Guide for Authors for further details of any item.
Ensure that the following items are present:
One author has been designated as the corresponding author with contact details:
• E-mail address
• Full postal address
• Telephone
All necessary files have been uploaded, and contain:
• Keywords
• All figure captions
• All tables (including title, description, footnotes)
Further considerations
• Manuscript has been 'spell-checked' and 'grammar-checked'
• All references mentioned in the Reference list are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including

the Web)
• Color figures are clearly marked as being intended for color reproduction on the Web (free of charge) and in print, or to be reproduced in color on the Web (free of charge) and in black-and-white in print
• If only color on the Web is required, black-and-white versions of the figures are also supplied for printing purposes
For any further information please visit our customer support site at http://support.elsevier.com.

Appendix S

End of study notification to be submitted on termination of the study

This has been removed from the electronic copy

Appendix T

Summary report to be submitted to research ethics committee and copied to R&D departments on completion of the study

Background: Autobiographical memories (AMs) are past, personal recollections of facts (semantic AM) and events (episodic AM). The ability to mentally "relive" past events in the mind's eye has been linked to a person's sense of self, their identity. Current theoretical understanding of how AMs are relived suggests that other cognitive functions including working memory (WM) and executive functions (ExF) enable the cognitive search through semantic AM knowledge, which facilitates access to the episodic AMs which are subsequently retrieved and "relived". However, there remains a lack of consensus as to the nature of the relationships between these cognitive functions and semantic and episodic aspects of AM.

Aim: The present study therefore aimed to explore the associations between these variables in a sample with a wide range of ability on measures of WM, ExF, and AM.

Design: The study incorporated a between-groups component, and a correlational component with regression and mediation modelling.

Method: Participants with Alzheimer's disease (n = 10) and healthy controls (n = 10) matched for age, education, and intellectual ability were assessed on measures of semantic and episodic AM search and retrieval, auditory and spatial WM, and verbal fluency.

Results: People with AD retrieved AMs that were significantly less episodic in nature compared to controls. There were no significant associations between WM measures and search of semantic AM, or episodic AM retrieval. Verbal fluency predicted episodic AM

retrieval and mediated the effect of dementia status on episodic AM retrieval independent of age effects. WM did not mediate episodic AM retrieval.

Conclusions: People with AD may be limited in their retrieval of episodic AM due to weaker verbal fluency, independent of the typical effects of ageing on decline in episodic AM. WM appeared to play little role in facilitating episodic AM retrieval, contrary to some previous findings. Currently, the effects of reminiscence or AM-based psychological interventions for dementia are unclear, and the results of this study suggests that such interventions for people with AD would benefit from incorporating more structured, individualised external memory aids to facilitate more effective AM search and retrieval, which in turn might help to prolong the individual's sense of self and wellbeing.

Appendix U

Letter to ethics committee (to be sent on completion of study)

This has been removed from the electronic copy