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An examination of the Effectiveness of a Cognitive Group Intervention for People with Acquired Brain Injury

Thesis submitted to the Department of Psychology, Faculty of Science & Engineering, in
fulfilment of the requirements for the degree of Doctor of Philosophy, Maynooth University

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General Abstract

Neuropsychological rehabilitation is concerned with enabling people with brain injury to achieve their maximum potential in various domains such as psychological, social, leisure, vocational or everyday functioning. This study investigated, in a sample of people with Acquired Brain Injury (ABI), whether participating in a twelve-week group intervention brings about significant change in areas of cognition, community integration, satisfaction with life, distress, cognitive self-evaluation and knowledge of brain injury. Thirty-two participants (*n* = 32) with an ABI took part in this matched control study. Participants completed a series of neuropsychological tests (California Verbal Learning Test-Second Edition (CVLT-II); Trail Making Test; Sustained Attention Response Task (SART); and Digit-Span Task) and questionnaires (Community Integration Questionnaire; Satisfaction With Life Scale; Hospital Anxiety and Depression Scale; Cognitive Group Self-Evaluation; and Knowledge of Brain Injury Questionnaire) at three timepoints over a nine month period. Results showed a significant overall effect across the three timepoints in the intervention group on elements of the CVLT-II test and a significant overall effect across the three timepoints in both groups on elements of the Trail Making Test. A significant effect was seen between T1 and T2 in the intervention group on elements of the SART and Digit Span tests, and for the control group, significant effects between these two timepoints were seen on elements of the Trail Making Test, SART (target reaction time subscale) and the Digit Span test (disimprovment in performance between T1 and T2). Significant effects were seen between T2 and T3 for the intervention group on elements of the Trail Making Test and for the control group on elements of the CVLT-II test. Significant effects were seen between T1 and T3 for the intervention group on elements of the Trail Making and SART tests and for the control group, on elements of the CVLT-II test and Cognitive Self Evaluation questionnaire. There was a significant difference in Knowledge of Brain Injury scores for the main effect of time. This

study provides some support for the effectiveness of a group-based intervention combining psychoeducation, basic strategy training and stress management techniques for individuals with ABI and has important implications for neurorehabilitation service providers, individuals with an ABI and their families.

Chapter 1

General Introduction

1.1 Overview of the Human Brain

The human brain weighs approximately 1.3-1.4kg and sits inside a rough and bony skull, bathed in cerebrospinal fluid (Schater, Gilbert, Wegner & Hood, 2016). The cerebrospinal fluid is contained by a tough membrane inside the skull called the dura mater. Thin elastic fibres, called the arachnoid, connect the dura mater to the pia mater, a thin membrane on the surface of the brain (Watson, Kirkcaldie & Paxinos, 2010). Because the brain is so soft and easily damaged, the cerebrospinal fluid plays an important role in protecting the brain by acting as a shock absorber.

Nerve cells in the brain are called neurons and there are approximately 100 billion of them in the human brain (Kolb & Whishaw, 2011). Neurons communicate with each other, via a unique electro-chemical process, to perform information-processing tasks. Another type of cell in the brain are glial cells and these cells support the functionality of neurons by providing physical support, supplying nutrients and enhancing neuronal communication (Schater et al., 2016).

The cerebral cortex is the outermost layer of the brain and is made up of the right hemisphere and left hemisphere. It is responsible for complex aspects such as thought, perception, emotion and movement (Schater et al., 2016). Each hemisphere has four lobes; the frontal, parietal, temporal and occipital lobes. The frontal lobes are involved in initiation, planning, problem solving, and the direction of our behaviour, among other things (Coetzer, 2013) and these functions are sometimes referred to as executive control function. The frontal lobes also appear to have a role in many forms of short-term memory (Kolb & Whishaw, 2011). The frontal lobes contain a strip of brain tissue called the motor cortex, which initiates voluntary movements and sends messages to other parts of the brain and spinal cord (Schater et al., 2016). An important language area, known as Broca's area, is located in the left frontal lobe and controls the muscles of the face and mouth, important for expressive language and

fluency of speech. The frontal lobes are also thought to be involved in personality or patterns of behaviour unique to an individual (Coetzer, 2013).

The parietal lobes contain the primary somatosensory cortex (which contains a representation of the body map) as well as multimodal regions, receiving information from somesthetic (bodily sensations), auditory, and visual neocortices (Wild, Heckemann, Studholme & Hammers, 2017). The temporal lobes are primarily involved in hearing, language and memory (Coetzer, 2013). Wernicke's area is located in the upper-left temporal lobe and governs a person's understanding of spoken and written language as well as the ability to make sense of the thoughts that are spoken. The occipital lobes are fairly extensively involved in vision. It should be noted that the individual lobes of the brain serve many more functions than highlighted here. Also, the different lobes do not function in isolation from each other, or from other structures in the brain; the brain mostly functions as an integrated whole (Coetzer, 2013). Multiple cortical and subcortical areas are involved in complex interrelationships in the mediation of even the simplest behaviours (Fuster, 1995; Mesulam, 2009; Seeley et al, 2009) and specific brain regions are typically multifunctional (Lloyd, 2000). Cortical activity is maintained and modulated by complex feedback loops that constitute major subsystems, some within the cortex and others involving subcortical centres and pathways (Lezak, 2012).

The part of the brain that sits on top of the spinal cord is the hindbrain, also known as the brainstem (Schater et al., 2016). This area of the brain controls basic life functions such as breathing, alertness and motor skills (Schater et al., 2016). The three anatomical structures that make up the hindbrain are the medulla, the cerebellum and the pons. There are also several important subcortical structures located deep inside the brain. These include the thalamus, hypothalamus, pituitary gland, limbic system and basal ganglia. "These structures

play an important role in relaying information throughout the brain as well as performing tasks that allow us to think, feel and behave as humans" (Schater et al., 2016, p.106).

From a neuropsychological perspective, one of the most important internal brain structures is the limbic system (Coetzer, 2013). The limbic system consists of the cingulate gyrus, hippocampal formation, amygdala, septum, formix, and hypothalamus. The limbic system is closely involved in the functions of memory, motivation, and emotion with the hippocampus specifically involved in memory (Coetzer, 2013). See Fig. 1.1. below.

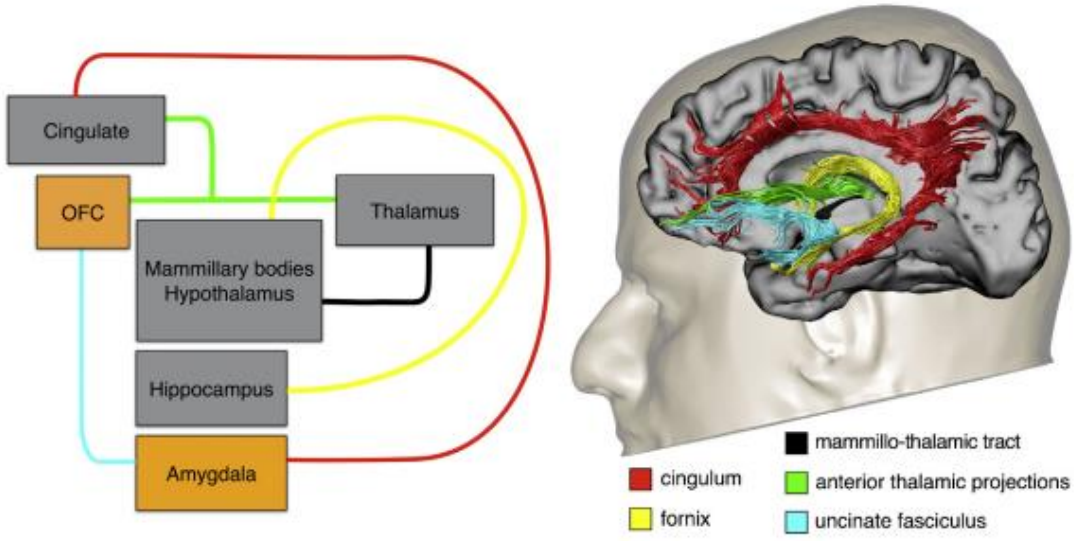

Fig 1.1 Diagrammatic representation of the limbic system and tractography reconstruction of its main pathways. The colours in both figures correspond to the tracts in the legend.

1.2 Characteristics of Acquired Brain Injury

Acquired Brain Injury (ABI) is defined as *'an inclusive category that embraces acute (rapid onset) brain injury of any cause'* (National Clinical Guidelines for Rehabilitation Following Acquired Brain Injury - Royal College of Physicians & British Society of Rehabilitation Medicine, 2003). Causes of ABI are many and include both traumatic and non-traumatic causes. Traumatic brain injuries can be caused by road traffic accidents, falls, assault, post-

surgical damage (e.g. following tumour removal) or sports injuries, whereas non-traumatic injuries include infections (such as herpes encephalitis), tumours, metabolic conditions including liver and kidney disease or diabetic complications, toxins, and cerebral–vascular incidents such as subarachnoid haemorrhages, aneurysms, clots, and other strokes (Entwistle & Newby, 2013). Globally, ABI is among the most prevalent neurological impairment, affecting approximately 200 per 100,000 individuals (Hyder, Wunderlich, Puvanachandra, Gururaj and Kobusingye, 2007).

1.3 Consequences of ABI

The characteristic that most distinguishes individuals who have ABI is the heterogeneity of their symptoms (High, Sander, Struchen & Hart, 2005), meaning that each brain injury is unique to the individual and the degree of functional impairment can vary greatly. ABI is associated with a high likelihood of life-long functional changes, including a range of physical, cognitive, emotional and behavioural changes (e.g. headaches, memory loss, depression and aggression) and these changes are frequently associated with both personal and social difficulties for individuals (Jones, Haslam, Jetten, Williams, Morris & Saroyan, 2011). Cognitive impairments can result in reduced independence and lack of community integration (High et al., 2005), which in turn can lead to social isolation. The frontal lobes, including the prefrontal cortex, are commonly injured in traumatic brain injuries and this can be especially debilitating since the frontal cortex plays a role in many executive functions, working memory, motivation, emotional regulation and many aspects of personality.

Motor impairments are common following damage to the brain in the motor and pre-motor areas, the basal ganglia and the cerebellum (Entwistle & Newby, 2013). Visual impairments are also common following brain injury and common sensory changes include an increased sensitivity to light, changes to smell and taste, an altered sensitivity to

temperature, and a reduction in limb pain sensations (Entwistle, & Newby, 2013). In addition, hearing loss is common after brain injury, as well as ongoing pain, particularly headaches, which can be very disabling (Entwistle, & Newby, 2013). Seizures are commonly seen around the time of injury, and individuals with a TBI generally have a risk of developing epilepsy that is twenty-nine times higher than that in the general population (Herman, 2002).

1.3.1 Theories and Models of Memory

Memory involves encoding, storing and retrieving information from short- and long-term memory systems and is required for cognitive, emotional, social and vocational functioning throughout the lifespan (Tulving & Craik, 2000). Much of the information entering our consciousness in short-term memory is rapidly over-written by newer information, without being encoded to memory storage (Cullen & Evans, 2014). Working memory refers to information that is retained for short periods and manipulated 'online' and long-term memory involves information being retained for minutes or longer, where rehearsal is prevented (Cullen & Evans, 2014).

Baddeley and Hitch's (1974) Working Memory (WM) model, which has been refined over time (e.g. Baddeley, 2000, 2007), is one of the most widely known and enduring concepts in cognitive psychology (Fish & Manly, 2017). 'Working memory' is a reference to a set of temporary cognitive stores in which information is maintained and manipulated and it is the system associated with being aware of the contents of one's mind and beginning to use those contents to achieve goals (Fish & Manly, 2017). The model envisages three subcomponents (the phonological loop, visuospatial sketchpad and episodic buffer) which are under the control of an overarching component called the Central Executive (Cullen & Evans, 2014). Current debates remain about the nature of the component systems in working memory and Logie (2016) has recently questioned the relevance of the 'central executive'

component of working memory given the advances in our understanding of executive control processes. Working memory is strongly linked with attention, the executive component overlaps with broader conceptions of executive functioning and there are also important links between working memory and emotion (Fish & Manly, 2017). Given the relationship between working memory and other domains, impairments in working memory may impact across these domains.

Working memory tasks that call for temporary storage and manipulation of information are thought to involve the frontal lobes (Braver, Cohen, Nystrom, Jonides, Smith & Noll et al, 1997). Damage to the prefrontal lobes can disrupt relationships between the major functional systems, including the limbic-memory system (Lezak et al., 2012). Working memory tends to follow basic left-right laterality principles, with functional imaging studies showing preferential activation in the left dorsolateral prefrontal area during verbal working memory tasks (Lezak et al., 2012).

Distinctions within long-term memory include: (i) declarative/explicit (operates within conscious awareness); (ii) implicit aspects (non-conscious procedural skills and classical conditioning; (iii) anterograde memory (memory for information/events encountered after the onset of a memory disorder); (iv) retrograde memory (memory for information/events encountered before the onset of a memory disorder; and (v) prospective memory (remembering to act on an intention at a later time; Cullen & Evans, 2014). Declarative/explicit memory can be further sub-divided into episodic memory (memory for events and context) and semantic memory (memory for facts). The distinction between episodic and semantic memory forms the foundation of much of the theoretical debate and experimental work in memory research in the past half century (Cullen & Evans, 2014). Different models of memory consolidation (the process of a memory trace being laid down into memory storage) have emerged in the literature and stimulated a substantial body of

experimental research in the past few decades. The best known models include the Standard Consolidation Model and Multiple Trace Theory (MTT; Cullen & Evans, 2014).

1.3.2 Memory Impairments Following Brain Injury

Memory problems are amongst the most commonly reported cognitive deficits arising from ABI (Velikonja, Tate, Ponsford, McIntyre, Janzen, & Bayley, 2014) and they can have debilitating functional consequences. Individuals who experience localised injury in the temporal lobes, hippocampus and amygdala are particularly susceptible to memory impairment (Cicerone, Dahlberg, Kalmar, Langenbahn, Malec, Bergquist et al., 2000). Memory involves many different interacting cognitive systems, including attention and executive functions, therefore any condition that affects the physical or functional integrity of the brain is likely to impact on some aspect of a person's ability to remember (Wilson, Gracey, Evans & Bateman, 2009). Memory deficits may be predominantly episodic, semantic, visuospatial, verbal, or contextual, and may involve short-, intermediate-, or long-term processes (Lajiness-O'Neill, Erdodi, Mansour & Olszewski, 2013). Memory deficits can compromise a person's safety in the home (for example, forgetting to turn the stove off), the community (for example, forgetting the rules of the road), and at work (for example, forgetting important documents; das Nair, Lincoln, Ftizsimmons, Brain, Montgomery, Bradshaw et al., 2015).

Problems with working memory are common following traumatic brain injury (McHugh, Niewoehner, Rawlins, & Bannerman, 2008). Working memory is the cognitive system that simultaneously processes and stores information over the short term and it enables individuals to carry out complex cognitive tasks such as reading, auditory language comprehension, arithmetic, and occupational activities which impose memory loads that must be maintained and updated over time (Newsome, Scheibel, Steinberg, Troyanskaya, Sharma,

& Rauch, 2007). These cognitive difficulties can impact on a person's life and consequently psychosocial outcomes. In a study of cognitive predictors of long-term psychosocial outcome following TBI, Wood and Rutterford (2006a) found that working memory was the only cognitive function associated with outcome, measured according to community integration, life satisfaction, and depression.

Memory impairment often gives rise to difficulties with retrospective memory (difficulty recollecting previously acquired information), prospective memory (forgetting to perform intended actions in the future) or learning novel information (Wilson, Winegardner, Van Heugten & Ownsworth, 2017). Prospective memory involves executive processes such as planning, disruption of ongoing activity, and initiation of an action (Shum, Fleming & Neulinger, 2002), which are generally associated with the frontal lobes (Demakis, 2004). Difficulties with prospective memory may limit participation in rehabilitation programmes given that such programmes typically require participants to remember to turn up for appointments, complete homework and remember to take prescribed medication (Fleming, Shum, Strong, & Lightbody, 2005; Fleming, Riley, Gill, Gullo, Strong, & Shum 2008). Prospective memory studies have indicated that the magnitude of impairment varies according to specific task parameters (Shum, Levin, & Chan, 2011) and that time-based tasks are disproportionately impaired, in comparison to event-based tasks (Kinch & McDonald, 2001; Mathias & Mansfield, 2005).

1.3.3 Theories and Models of Attention

Definitions of attention vary widely (Lezak, Howieson, Bigler & Tranel, 2012), however one definition is that it is the process whereby information processing resources are differentially allocated (Klein & Lawrence, 2011). Lezak et al., (2012) refers to attention as a system in which processing occurs sequentially in a series of stages within different brain systems,

organised in a hierarchical manner. According to Klein & Lawrence (2011), differential allocation occurs in two modes, namely endogenous (internally generated) and exogenous (externally cued), and across four domains (time, space, sense, task). Posner & Petersen (1990) provided an influential framework for understanding human attention, which they have recently updated (Petersen & Posner, 2012). They state that attention is anatomically separate from other cognitive systems which handle incoming stimuli, make decisions, and produce outputs and that it comprises three functions across a network of brain areas, namely alerting, orienting and executive attention (Petersen & Posner, 2012).

The alerting system, referred to as arousal, sustained attention and vigilance, maintains a state of readiness to respond and the alerting network includes the brain stem, reticular formation and thalamus (Petersen & Posner, 2012). The orienting system prioritises information across sensory modality and space and is also referred to as selective attention (Petersen & Posner, 2012). The orienting network includes areas of the frontal lobe, parietal lobe and the temporoparietal junction. The mechanism by which attention is directed towards our goals is referred to as 'executive attention' (Petersen & Posner, 2012). Executive attention consists of two component processes, one for 'setting up' a task according to its main goal and the other for maintaining focus on that task (Petersen & Posner, 2012). According to Petersen & Posner (2012), frontal and parietal brain areas are involved in executive attention, in particular the medial frontal lobe, anterior cingulate cortex and insula.

A salient characteristic of the attentional system is its limited capacity which varies not only between individuals but also within each person at different times and under different conditions (Lezak et al., 2012). Stuss and Benson's (1986) hierarchical model of cerebral organisation defines attention as the foundation of the hierarchy of functional systems and therefore attention is a skill that supports other cognitive abilities (Cappa, Benke, Clarke, Rossi, Stemmer & van Heugten, 2005; Posner & Petersen, 1990). If an individual is

experiencing deficits in attention, all their cognitive functions may be intact and the person may even be capable of some high-level performances, yet overall cognitive productivity suffers (Lezak et al., 2012). Fish (2017) highlights the overlap between what we refer to as attention and other concepts, including speed of information processing, working memory and executive functioning, with boundaries neither immediately obvious nor absolute.

Disorders of attention may arise from lesions involving different points in the attentional system. Lesions in cerebral white matter sever connections between lower and higher centres or between cortical areas within a hemisphere or between hemispheres. White matter lesions are often associated with slowed processing speed and attentional impairments (Lezak et al., 2012). The prefrontal cortex is among many structures involved in attention and the right prefrontal cortex is considered important for sustained attention (Vendrell, Junqué, Pujol, Jurado, Molet, & Grafman, 1995). The dorsolateral prefrontal cortex integrates attention, memory, motor and affective dimensions of behaviour (Lezak et al., 2012).

1.3.4 Attention Impairments Following Brain Injury

As early as the 1970s, researchers proposed that deficits of attention were a common consequence of head injury that greatly impeded the recovery of other cognitive and functional abilities (Park & Ingles, 2001). Attentional impairments affect 40–60% of patients suffering mild brain injury (Sivan, Neumann, Kent, Stroud & Bhakta, 2010) and in the case of severe ABI, longitudinal studies have demonstrated persisting deficits in more than 60% of patients ten years post-injury (Ponsford, Downing, Olver, Ponsford, Archer, Carty & Spitz, 2014). Attentional difficulties can interfere with many aspects of daily functioning (Lewis & Horn, 2013) and even quite a small reduction in an individual's attention ability may significantly reduce the capacity for new learning and affect academic performance (Kinsella, Prior, Sawyer, Ong, Murtagh, Eisenmajor, et al., 1997; Kinsella, 1998). Individuals with ABI

may report distractibility, the neglect of environmental cues, difficulties with multi-tasking and being unable to concentrate for a sustained period of time (Entwistle & Newby, 2013).

Common attentional difficulties after brain injury include deficits in speed of processing, attentional capacity, sustained and selective attention, and supervisory attentional control (Mathias & Wheaton, 2007). Selective attention deficits, which result in the inability to filter out irrelevant information, have been shown to be a particular problem following TBI (Robertson & Schmitter-Edgecombe, 2017). Such deficits can lead to increased distractibility, a tendency to become overloaded and challenges with staying on task, all of which can negatively impact rehabilitation efforts (Bate, Mathias & Crawford, 2001). Behavioural disorganisation and goal neglect may reflect reduced capacity for sustained attention, involving the endogenous control of attentional resources to maintain task goals and goal-directed behavior (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997; Sarter, Givens, & Bruno, 2001).

1.3.5 Theories and Models of Executive Functioning

Though executive functioning is sometimes defined as a unitary construct, it is commonly recognised that it comprises a range of different but related neuropsychological dimensions (Allanson, Pestell, Gignac, Yeo & Weinborn, 2017). Lezak (1982, 1987) coined the term 'executive function' to describe skills used to formulate goals, to plan strategies to achieve those goals, and to self-evaluate one's performance during these activities. Lezak (1982) distinguished higher order executive function from hierarchically lower cognitive functions based on the problems with which they are associated. However, the construct and definition of executive function are still complex and unclear, which is reflected in the diversity of terms that can be found in the literature to designate executive functioning (Dores, Carvalho, Barbosa, Martins, de Sousa & Castro-Caldas, 2014).

Executive functions are viewed as including different processes and subprocesses and can be conceived as a supervisory capacity for directing more modular or specific processes (Dores et al., 2014). Executive functions are viewed as resulting from the combination of cognitive (e.g., working memory, inhibitory control), emotional, and behavioural processes, and this is reflected in the diversity of models (Dores et al., 2014).

Several models of executive functioning have been developed. Norman & Shallice (1986) developed their cognitive schemata theory which specified all behaviour as the unfolding of mental schemas, which are basic units underlying action and thought. Their cognitive schemata theory includes a supervisory attentional control system (SAS) which is required to operate on and select the relevant schemas in novel non-routine situations (Norman & Shallice, 1986). In a model of executive function developed by Stuss (2011), instead of a unitary executive control mechanism he suggests parallel processes across domains acting in concert to accomplish control. Miyake, Friedman, Emerson, Witzki & Howeter (2000) proposed an influential and empirically supported multi-dimensional model of executive functioning (Allanson et al., 2017). Their model consists of three executive components, namely (1) shifting back and forth between tasks, operations, or mental sets; (2) updating of information in working memory; and (3) controlled inhibition of automatic responses (Miyake et al., 2000). Miyake et al.'s (2000) model has since been expanded upon by others, with two additional dimensions proposed (access or generativity and fluid reasoning; Allanson et al., 2017).

Ylvisaker (1998) suggest eight aspects of executive function important for complex goal-directed task behaviour, including: (1) awareness of one's capacities and needs; (2) goal setting; (3) planning; (4) initiation; (5) monitoring; (6) inhibition of behaviour that does not lead to the goal; (7) flexibility and problem solving; and (8) strategic behaviour – the ability to retain a successful task approach and generalise it to other situations.

1.3.6 Executive Functioning Impairments Following Brain Injury

Individuals with executive function deficits may show an extensive array of symptoms which can very widely in degree and extent between individuals, regardless of aetiology (Spikman, 2017). Problems with organisation and development of efficient strategies for completing everyday tasks is one of the most common and persistent sequelae following ABI, affecting individuals' ability to function independently in daily life (Krasny-Pacini, Chevignard & Evans, 2014). Deficits in goal management (cognitive abilities that are involved in the control of goal-directed behaviour, including planning, monitoring, inhibiting, maintaining sustained attention and task switching) are often the main cognitive complaint made by patients with TBI (Mateer Sohlberg, & Crinean, 1987). Due to the fact that executive functioning influences a host of other cognitive processes, difficulties in this domain can be pervasive, affecting all aspects of daily functioning (Tsaousides & Gordon, 2009). Executive functioning problems arise from damage to the frontal lobes or to circuits that include frontal structures (Stuss, 2011). There is growing recognition of the importance of the interconnectivity between different brain regions and of their active role in executive functioning (Dores et al 2014). For this reason, problems with executive functioning can emerge when individuals have lesions in areas other than the frontal lobes (Duffau, 2012; Jacob, Harvey & Andreson, 2011).

Baddeley & Wilson (1988) introduced the term 'dysexecutive syndrome', to encompass a broad range of disturbed behaviours including impulsivity, distractibility, apathy, problems in learning new tasks and inappropriate behaviour in social situations. Executive function deficits affect the ability to formulate goals, initiate behaviour, plan and organise behaviour, anticipate the consequences of actions, and monitor and adapt behaviour to fit a particular task or context (Cicerone et al., 2000). Disorders of executive functions vary between individuals. For example, some individuals may have difficulty solving everyday

problems because they cannot generate alternative solutions, others may be able to generate alternative solutions to problems but cannot predict when problems will arise, while others could have difficulty organising and prioritising the steps that it takes to solve a problem (Kennedy, Coelho, Turkstra, Ylivisaker, Sohlberg, Yorkston et al., 2008). Executive functioning deficits can be particularly challenging for individuals as impairments in this area can impact a person's ability to effectively employ their intact areas of functioning, hampering attempts to employ compensatory strategies (Lewis, Babbage & Leathem, 2011).

1.3.7. Psychosocial Difficulties Following Brain Injury

ABI can result in changes in mood, emotional control and behavioural regulation which can hinder or facilitate treatment and daily functioning (Dams-O'Connor & Gordon, 2013). People with ABI often experience difficulties in regulating their thoughts and reactions to internal or environmental triggers (Shields, Ownsworth, O'Donovan & Fleming, 2016). Changes can result from neuropathological and neurochemical changes, stress disorders related to the traumatic events surrounding the injury, adjustment reactions to disability and injury-related limitations, pre-existing psychological factors, or a combination of each (Dams-O'Connor & Gordon, 2013). Many individuals with brain injury struggle with the challenges to their identity, worry about their future occupation, finances, relationships, and health, as well as becoming socially anxious and isolated (Entwistle & Newby, 2013). In a longitudinal study by Ponsford, Downing et al. (2014), marital status remained stable over a ten year period, however approximately 30% of participants reported difficulties in personal relationships.

Psychosocial sequelae post-injury can be more socially debilitating than physical disability, leading to social isolation, caregiver stress, and unemployment (Thomsen, 1984). A study by Yang, Tu, Hua & Huang (2007) investigating clinical outcomes for patients with mild traumatic brain, found that the physical symptoms had more adverse impacts on

outcomes during the acute stage after TBI, whereas emotional disturbances had more adverse impacts during the sub-acute stage after trauma.

Symptoms of anxiety and depression are commonly reported following brain injury and this can provide ongoing challenges for individuals and their families (McBrinn, Wilson, Caldwell, Carton, Delargy, McCann, et al., 2008). The prevalence of depression is similar after both stroke and TBI with the order of 20–40% affected at any point in time in the first year, and about 50% of people experiencing depression at some stage (Fleminger, Oliver, Williams and Evans, 2003), with levels significantly higher than the neurologically healthy population. Rates of comorbid depression and anxiety in the ABI population is estimated at 60-70% (Jorge & Arciniegas, 2014).

Ponsford, Draper & Schonberger (2008) suggest that anxiety and depression may be caused by trying to cope with significant cognitive disability, or alternatively, may be a more direct result of the injury, contributing to avoidance of participation in certain activities, resulting in reduced functional outcome levels. McBrinn et al. (2008) found that people with brain injury who had better awareness of their difficulties had higher emotional distress, regardless of time since injury. As survivors of brain injury become more aware of their losses and the implications of the injuries for their life goals and social roles they may suffer more emotional distress (Williams & Evans, 2003). Ponsford et al. (2008) found that anxiety was most evident in those with the more severe injuries, while the levels of depression tended to be somewhat higher in those with milder injuries. This suggests the possibility that poor self-awareness in those with severe injuries reduced the likelihood of depression, at least in some cases.

Psychosocial functioning plays an important role in the recovery of patients. Mood disorders such as anxiety or depression, which also impair concentration, can reduce the efficiency of memory post brain injury (Wilson et al., 2009). Radford, Lah, Thayer, Say &

Miller (2012) found that level of depression was a significant independent predictor of benefit from a group-based memory training programme, with higher levels of depression attenuating subjective prospective memory gains. The authors suggest that engagement in depression treatment initially, followed by memory training may be a worthwhile approach for some patients (Radford et al., 2012).

In a longitudinal study, Pagulayan, Temkin, Machamer & Dikmen (2006) investigated the quality of life (QoL) of patients with TBI at 1 month, 3 years and 5 years post-injury and found that although the physical domain of QoL improved over time, the psychosocial domain of QoL did not attain a normal level. Other studies have found that psychosocial adjustment may take several years but improvements can be seen many years post injury. Whitnall, McMillan, Murray & Teasdale (2006) evaluated disability in patients with TBI 5-7 years post-injury. They reported that 53% of patients remained disabled at 5–7 years after injury and that the persistence of disability was strongly associated with depression, anxiety and low self-esteem. They evaluated the longitudinal data for clinical outcomes and results revealed that 60% of patients with TBI achieved favourable outcomes at 10 years post-injury (Whitnall et al., 2006). In a study by Wood & Rutterford (2006) of a severe brain injury population who were at least 10 years post-injury, they found that 72% of patients were capable of independent living and 41% were in either full or part time employment, indicating that long term psychosocial outcome following serious head injury may be better than expected. A longitudinal study by Ponsford, Downing, Olver, Ponsford, Archer, Carty et al. (2014) of patients with TBI found that levels of independence in activities of daily living were high during a 10-year period, and as many as 70% of subjects returned to driving. However, approximately 40% of patients required more support than before their injury and only half of the individuals returned to previous leisure activities. In a longitudinal study by Huang, Ho & Yang (2010) which investigated outcomes of patients with TBI, the authors

found that patients with TBI still suffered from difficulties in social interactions and family relationships 6 years post-injury, even though they could live and work independently. The authors found that the recovery process of each patient is very different, with some patients able to work independently at 3 months after injury, whilst others still needed help from their caregivers to deal with activities of daily living (ADL) at 3 years post-injury (Huang et al., 2010). They also found that family relationships and social activities were the most important factors associated with recovery of clinical outcome post-injury (Huang et al., 2010).

Community integration is considered one of the ultimate goals of rehabilitation after brain injury (Fortune & Richards, 2017). Community integration is generally considered to represent "a person's ability to carry out everyday activities in their home and community, enjoy interaction with its members, and participate in some aspect of productivity" (Fortune & Richards, 2017, p.2). There are several different frameworks for community integration in the literature, however the Community Integration Framework (CIF; Parvaneh & Cocks, 2012) is the only framework whose design is based on input from key stakeholders in ABI, including researchers, policy-makers, people with ABI and their families and practitioners (Parvaneh, Cocks, Buchanan & Ghahari, 2015). The CIF encompasses seven areas: Relationships, Acceptance, Community Access, Occupation, Being at Home, Picking Up Life Again and Heightened Risks and Vulnerability (Parvaneh & Cocks, 2012).

The World Health Organisation's International Classification of Functioning, Disability, and Health (ICF, 2001) is a guiding force in rehabilitation services and directs efforts towards maximising activity and participation (Lewis et al., 2011). According to the WHO's ICF (2001), rehabilitation outcomes can be considered in three categories: (1) 'Body Functions and Structures' which refers to the physical level of body structures and their associated functions; (2) 'Activities' which involves such things as feeding, dressing, shopping, and driving; and (3) 'Participation' which occurs at the societal level and is an

interaction between the person and the environment in social roles, involving such things as being a worker, student, friend, spouse or parent (Stiers, Carlozzi, Cernich, Velozo, Pape, Hart, et al., 2012). While rehabilitation interventions to improve body functions & structures and activities are important, it is participation that is most strongly linked to perceived quality of life (Stiers et al., 2012).

Research on the employment rates of patients with TBI have been inconsistent (Huang et al., 2010). Some studies (Andelic, Hammergren, Bautz-Holter, Sveen, Brunborg, & Roe, 2009; Rao, Rosenthal, Cronin-Stubbs, Lambert, Barnes & Swanson, 1990) have reported a relatively high employment rate in patients with TBI. However, others have shown that individuals with TBI may have difficulty resuming occupational involvement (Colantonio, Ratcliff, Chase, Kelsey, Escobar & Vernich, L., 2004; Goranson, Graves, Allison & La Frenieres, 2003). Kreutzer, Marwitz, Walker, Sander, Sherer, Bogner et al. (2003) and Possl, Jurgensmeyer, Karlbauer, Wenz & Goldenberg (2001) found that work was not a stable factor for almost half of the employed patients at 4 years post-injury. Possl et al. (2001) reported a 53% employment rate amongst individuals who had a severe TBI, but 28% of patients retired within a 2-year period after an unsuccessful work trial indicating that long-term maintenance of employment can be a problem post brain injury. In a longitudinal study of patients with TBI, fewer than half were employed at each assessment (two, five and ten years) post-injury (Ponsford, Downing et al., 2014).

Life satisfaction is one factor in the more general construct of subjective wellbeing (Goverover and Chiaravalloti, 2014). Individuals with brain injury have been found to report lower levels of life satisfaction in comparison with healthy individuals (Dijkers, 2004) and community integration may be associated with the subjective experience of life satisfaction (Reistetter & Abreu, 2005). In a study by Stalnacke (2007), a strong correlation was found between depression and life satisfaction, indicating that the level of life satisfaction decreases

with increasing scores of depression. Similarly, a study by Goverover & Chiaravalloti (2014) found that symptoms of depression were significantly associated with lower satisfaction with life as well as self-reports of poor memory abilities and lower quality of life. Another study by Wood & Rutterford (2006a) found that injury severity was predictive of life satisfaction. Because satisfaction with life encompasses such a wide range of life features, it is a key factor in successful brain injury rehabilitation (Mailhan, Azouvi & Dazord, 2005).

1.3.8. Fatigue Following Brain Injury

A common indirect effect of brain injury is fatigue and this can play an important role in psychosocial functioning several years post brain injury (Draper, Ponsford & Schonberger, 2007). There is no universally accepted definition of fatigue, but it has been conceptualised as "the failure to initiate and/or sustain attentional tasks ('mental/cognitive fatigue') and physical activities ('physical fatigue') requiring self-motivation" (Chaudhuri & Behan, 2000, p. 35). A number of models of fatigue have been proposed over the last number of years (Eilertsen, Ormstad & Kirkevold, 2013; Kluger, Krupp. & Enoka, 2013; Lerdal & Gay, 2009; Malley, Wheatcroft & Gracey, 2014; Wu, Mead, Macleod, & Chalder, 2015). Fatigue is considered to be multidimensional, including psychological, motivational, situational, physical and activity-related components (Cantor, Ashman, Bushnik, Cai, Farrell-Carnahan, Gumber et al., 2014). People with ABI commonly report three types of fatigue, namely physical, mental and emotional (Malley, 2017). The experience of fatigue is subjective in nature, and individuals with brain injury tend to describe their symptoms of fatigue as different from any fatigue they have ever experienced before (Barbour & Mead, 2012; Whitehead, Unahi, Burrell, & Crowe, 2016).

Previous studies have established fatigue as one of the most critical symptoms associated with poor outcome post brain injury, including impaired daily functioning and

substandard quality of life (Cantor, Ashman, Gordon, Ginsberg, Engmann, Egan et al., 2008; Ouellet & Morin, 2006; Schiehser, Twamley, Liu, Matevosyan, Filoteo, Jak et al., 2015). In addition, it has been suggested that fatigue poses the greatest barrier to rehabilitation (de Groot, Philips & Eskes, 2003). The estimated incidence of fatigue following TBI is between 21 - 70% across the range of injury severity (Cantor et al., 2014) and between 35-92% of people following stroke (Duncan, Wu, & Mead, 2012; Nadarajah & Goh, 2015), depending on definitions, assessment tools used and time since injury. In a longitudinal study of patients with TBI by Ponsford, Downing et al. (2014), fatigue was one of the most common neurological symptom reported, with rates decreasing only slightly during the 10-year period.

Fatigue can result in debilitating and persistent problems for individuals with brain injury of all severities (Ponsford, Ziino, Parcell, Shekleton, Roper, Redman et al., 2012) and can persist for up to ten years post-injury (Duncan et al., 2012; Ponsford, Downing et al., 2014). Two characteristics of mental fatigue are that patients easily become exhausted and there is generally a long recovery time (Johansson & Rönnbäck, 2017), however underlying mechanisms remain unclear (Cronin & O'Loughlin, 2018). Malley et al., 2014 call for more research into the subjective and objective aspects of fatigue, and their interplay.

Fatigue may be difficult to distinguish from related phenomena such as depression, apathy, and sleep disturbances (Dornonville de la Cour, Forchhammera, Mogensenb & Norup, 2018). In both stroke and TBI patients, fatigue has been found to be associated with depression (Mollayeva, Kendzerska, Mollayeva, Shapiro, Colantonio & Cassidy, 2014; Ponchel, Bombois, Bordet, & Hénon, 2015; Wu, Barugh, Macleod, & Mead, 2014). Ponsford, Schönberger, & Rajaratnam (2015) propose that fatigue after TBI is a cause, not a consequence, of anxiety, depression, and daytime sleepiness, which, in turn (especially depression), may exacerbate fatigue by affecting cognitive functioning. Beaulieu-Bonneau & Ouellet (2017) found a general pattern of a reduction in fatigue levels over time after mild

TBI, an increase of fatigue after severe TBI, and stable fatigue after moderate TBI. They also found that depression, insomnia, and cognitive difficulties remain strong correlates of fatigue, while for pain and work status the association with fatigue evolves over time.

1.3.9. Awareness/Insight Deficits Following Brain Injury

Self-awareness is essential for maintaining and updating our self-understanding based on ongoing life experiences (Stuss, 2007). Impaired self-awareness refers to lack of knowledge of changes in personal abilities and the implications of these changes for daily living and the future (Fleming, Strong & Ashton, 1996). Markovic (2018) describes insight as a continuum whereby individuals may show awareness in some areas but not in others. Gaining insight can be seen as an active, oscillatory process and specific to a situation and time (Markovic, 2018). Individuals with a brain injury often lack awareness or insight into their deficits (known as anosognosia) and this lack of awareness can be a major barrier to successful rehabilitation (Lamberts, Fasotti, Boelen & Spikman, 2016; Prigatano & Schacter, 1991; Prigatano, 2013). Malia (2014) considers that developing good awareness is the key to successful rehabilitation.

Many authors use an integrated biopsychosocial approach to understanding self-awareness and self-identity, recognising that they are influenced by a dynamic interplay of pre-injury characteristics, neuro-cognitive factors, personal appraisals and reactions, and the social environment (Gracey & Ownsworth, 2012; Ownsworth, 2014; Yeates, Gracey & Collicutt McGrath, 2008). Theoretical models distinguish between self-knowledge that exists prior to task performance and the capacity to recognise difficulties during performance (Toglia & Kirk, 2000). Emergent awareness can punctuate the stream of everyday decision making (Dockree, Tarleton, Carton & Fitzgerald, 2015). Dockree et al. use the example of a person who has insight that their level of fatigue is affecting their concentration and so can

prompt an activity break, whereas if they lack insight that their concentration is waning, this can lead to goal neglect and error.

There does not appear to be a specific brain region or lesion site responsible for impaired self-awareness, but rather network disruption appears to underlie generalised awareness deficits (Ownsworth, 2017). In relation to people who have suffered a stroke, there is a greater incidence of a particular syndrome related to lack of awareness (anosognosia for hemiparesis), in patients with right hemisphere stroke compared to left hemisphere stroke (Appelros, Karlson, Seiger & Nydevik, 2002). Poor self-awareness has been associated with executive dysfunction (Bivona, Ciurli, Barba, Onder, Azicnuda, Silvestro et al., 2008; Noe, Ferri, Caballero, Villodre, Sanchez & Chirivella, 2005; O'Keeffe, Dockree, Moloney, Carton, & Robertson, 2007) and greater injury severity (Dirette, Plaisier, & Jones, 2008; Hart, Seignourel, & Sherer, 2009; Morton & Barker, 2010). A study by Reddy, Ownsworth, King & Shields (2017) found that more favourable ratings of pre-injury self were associated with poorer delayed memory and verbal fluency, suggesting that impaired episodic memory and executive control contribute to overly positive past reconstructions of self.

Impaired self-awareness usually refers to the overestimation of competencies, however some individuals underestimate their competencies post brain injury (Smeets, Vink, Ponds, Winkens & van Heugten, 2017). Lack of insight can negatively impact functioning, for example if a person doesn't recognise a memory problem they may not use compensatory tools, such as a shopping list when going to the supermarket. If an individual has reduced insight, they are unlikely to be motivated to engage in rehabilitation aimed at ameliorating their deficits (Dams-O'Connor & Gordon, 2013). With emerging awareness of deficits may come emotional distress. A study by Ownsworth (2016) found that increased self-awareness was associated with greater emotional distress at discharge and one month post-discharge but was no longer significant at three and six months post-discharge. Heightened awareness of

deficits or excessive focus on one's symptoms can also cause distress (Ownsworth et al., 2007). Ownsworth (2017) suggests that awareness deficits may initially act as a buffer against emotional distress, but does not protect from distress in the long-term. Ownsworth (2016) found that lower self-awareness was associated with poorer psychosocial functioning (independence, relationships and occupational participation) at all time points.

Radford et al. (2012) ran a group-based memory training programme and found that better self-awareness was associated with improvement on objective measures of both anterograde and prospective memory. This is consistent with previous findings linking self-awareness with rehabilitation success (Anson & Ponsford, 2006; Dirette, 2002; Noe et al., 2005). The authors suggest that those commencing the training programme with more accurate perceptions of memory function may have been able to identify and apply appropriate strategies to compensate for their particular difficulties more successfully than those with initially poor awareness (Radford et al., 2012).

1.4 Brain Plasticity After Brain Injury

Until the 1960s, human brains were believed to be fixed and unchanging. However, evidence has emerged over the last number of decades that human brains retain plasticity throughout the lifespan, with the cerebral cortex in particular being shaped by life experience and environment (Diamond, 2001). Brain plasticity refers to the idea that the cerebral cortex is not a fixed structure, but rather it can adapt to changes in sensory inputs. "Functions that were assigned to certain areas of the brain may be capable of being reassigned to other areas of the brain to accommodate changing input from the environment" (Schater et al., 2016, p. 111). With increased optimism regarding the potential for plasticity in the human brain, there is new hope and evidence regarding the potential for training of specific cognitive functions affected by brain injury (Nordvik, Schanke, Walhovd, Fjell, Grydeland & Landrø, 2012;

Rabipour & Raz, 2012; Tomassini, Johansen-Berg, Jbabdi, Wise, Pozzilli, Palace & Matthews, 2012). Neural plasticity will continue to influence the evolution of neurocognitive rehabilitation research and advance rehabilitation for neural injuries and disease (Crosson, Hampstead, Krishnamurthy, Krishnamurthy, McGregor, Nocera et al., 2017).

Sohlberg & Mateer (2001) explain the range of mechanisms that underlie neuroplasticity after brain injury and that are believed to be involved in recovery, including unmasking of existing circuits, functional reorganisation, modification of synaptic connectivity and inter-hemispheric competition. Chantsoulis, Mirski, Rasmus, Kropotov & Pachalska (2015) explain brain plasticity as "1) the spontaneous creation of new connections, which are extremely weak and which can disappear with time unless they are sufficiently strengthened; 2) the strengthening of the newly created connections in the spontaneous activity of the given patient, although in the overriding majority this is thanks to external stimulation" (p. 374). Cognitive rehabilitation therapy aimed at direct restoration is generally believed to be associated with restitutive reconnection, whereas compensation training is thought to be associated with reorganisation/ redistribution and use of adjacent and remote neuronal circuits (Laatsch, Thulborn, Krisky, Shobat & Sweeney, 2004).

1.5 Neuropsychological Rehabilitation Following Brain Injury

Brain injury rehabilitation can be considered a two way interactive process whereby individuals with a brain injury work together with professional staff and others to achieve their optimum physical, psychological, social and vocational wellbeing (McLellan, 1991). Cognitive rehabilitation spans a number of disciplines, including occupational therapy, speech & language therapy, physical medicine, neurology, cognitive psychology, cognitive neuroscience and neuropsychology and as a result incorporates many different theories and techniques (Brewer-Mixon & Cullum, 2013). Cognitive rehabilitation has come to be a

standard component of medical care following ABI (Rohling, Faust, Beverly & Demakis, 2009). There has been a dearth of published theoretical rehabilitation models and this has contributed to difficulties in reaching a consensus about how best to remediate cognitive dysfunction (Brewer-Mixon & Cullum, 2013). Modern approaches to cognitive rehabilitation tend to focus on one or more conceptual criteria that generally map onto the three principles of rehabilitation posed by Zangwill (1947), namely substitution, compensation, and direct training (Brewer-Mixon & Cullum, 2013).

Wilson (2017) suggests that it is unlikely that one theory, model or framework can address all the difficulties a person experiences following brain injury. Wilson (2017) argues that rehabilitation needs a broad theoretical base or bases and she published a provisional model incorporating many areas that need to be considered when planning rehabilitation programmes (Wilson, 2002). Wilson's provisional model includes factors relating to the patient and their family, the nature, extent and severity of brain injury, recovery patterns and the assessment of cognitive, emotional, psychosocial and behavioural problems (Wilson, 2002). Wilson's model (2002) also considers theories and models of language, reading, memory, executive functioning, attention and perception as well as assessment tools, theories of learning and evaluation of interventions. Learning theory and behaviour modification are intrinsically linked and have been used in cognitive rehabilitation for many years (Wilson, 2017). Behaviour therapy and behaviour modification techniques provide many strategies such as shaping, chaining, modelling, desensitisation, flooding, extinction, positive reinforcement and response cost, all of which can be adapated to suit particular rehabilitation purposes (Wilson, 2017).

One comprehensive approach to the retraining of a specific area of cognition that has gained attention is Sohlberg and Mateer's Attention Process Training (APT/APT-II; Brewer-Mixon & Cullum, 2013). This approach is based on a hierarchical model of attentional

abilities, ranging from simplest to most complex. The components of the model include: focused attention, sustained attention, selective attention, alternating attention and divided attention and this hierarchical model underlies and guides their approach to the rehabilitation of attention (Brewer-Mixon & Cullum, 2013).

A specific cognitive retraining model for addressing executive dysfunction called Goal Management Training was proposed by Robertson (1996). Individuals with executive dysfunction are trained to master five stages or steps, which are aimed at first reducing impulsivity and then helping patients plan, organise, perform a task, and then check their work after the task is completed.

Although there is not yet a widely accepted or comprehensive rehabilitation model for memory, substantial clinical and experimental work in this area has guided the development of various individual methods (Brewer-Mixon & Cullum, 2013). Common methods used by clinicians include errorless learning, spaced retrieval, vanishing cues and compensatory strategies such as mnemonics and visualisation/imagery techniques.

Some seminal publications in recent years have examined the state of the evidence for cognitive rehabilitation interventions following TBI and stroke (Cicerone et al., 2000; Cicerone, Dahlberg, Malec, Langenbahn, Felicetti, Kneipp et al., 2005; Cicerone et al., 2011; Cicerone et al., 2019; Gordon, Zafonte, Cicerone, Cantor, Brown, Lombard, et al., 2006; SIGN Guidelines, 2013). The conclusions drawn from these reviews support the effectiveness of cognitive rehabilitation as well as broader holistic neuropsychological rehabilitation interventions. Cicereone et al. (2005, 2011, 2019) reported that there is substantial evidence to support cognitive rehabilitation for people with TBI, including strategy training for mild memory impairment and post-acute attention deficits. In addition, there are recommendations for the provision of cognitive rehabilitation for people with acquired brain injuries; for example, the European Federation of Neurological Societies Guidelines on cognitive

rehabilitation (Cappa et al., 2005). However, such proposals are qualified by statements that highlight the need for more research, to support the recommendations (das Nair et al., 2015).

Cognitive rehabilitation interventions are commonly classified as either restorative or compensatory (Dams-O'Connor & Gordon, 2013). Restorative or 'bottom-up' interventions target basic cognitive skills/ functions such as arousal processes, attention and information processing, and involve repetitive drills or graded exercises (Mahncke, Bronstone, & Merzenich, 2006). This approach is based on the notion that by training the brain to encode and process increasingly complex stimuli, more accurately and more quickly through intensive procedural learning, restoration of these basic cognitive functions may occur with practice (Dams-O'Connor & Gordon, 2013). A restorative approach has the potential of improving functions in all aspects of a person's life, not just those directly trained (Raskin, Williams & Aiken, 2018). This can then follow with advanced training in higher-order cognitive skills (including memory, self-monitoring and executive functioning), but Cicerone et al. (2011) argue that restorative interventions alone are unlikely to generalise to untrained tasks. Compensatory or 'top-down' approaches "address deficits in higher-order 'executive' functions through the instruction and systematic practice of principles, strategies or rules that can be generalised across a variety of situations" (Dams-O'Connor & Gordon, 2013, p.52). Currently, cognitive rehabilitation is largely focused on the development of effective compensatory strategies (Lewis et al., 2011), given that generalisation of restorative training to non-trained domains of cognitive function has not been consistently demonstrated (Smith, Housen, Yaffe, Ruff, Kennison, Mahncke & Zelinski, 2009).

Dams-O'Connor and Gordon (2013) propose a synergistic approach to neurorehabilitation, integrating restorative or "bottom-up" interventions and compensatory or "top-down" approaches. Several studies have demonstrated the importance of incorporating both direct restorative interventions and compensatory strategy training to maximise

treatment results and to enhance generalisation of learned skills (Meinzer, Djundja, Barthel, Elbert, & Rockstroh, 2005; Poggel, Kasten, & Sabel, 2004; Sohlberg, Avery, Kennedy, Ylvisaker, Coelho, Turkstra, & Yorkston, 2003; Tiersky, Anselmi, Johnston, Kurtyka, Roosen, Schwartz et al., 2005).

Neuropsychological rehabilitation, an intervention that can be used to address difficulties post brain injury, is "concerned with enabling people with cognitive, emotional or behavioural deficits to achieve their maximum potential in the domains of psychological, social, leisure, vocational or everyday functioning" (Wilson et al., 2009, p. xi). Another way of describing neuropsychological rehabilitation after ABI is as "a process of increasing the ability to solve problems, remain organised and focused, selectively remember relevant events, and engage in independent strategic behaviour while participating in tasks valued by the culture (in increasingly varied contexts, with gradually expanding domains of content) and with systematically decreasing support from others" (Jackson, & Hague, 2013, p.116).

It is recognised that cognition, emotion and psychosocial functioning are interlinked and all need to be addressed in the rehabilitation process (Wilson, 2011). Dams-O'Connor and Gordon (2013) emphasise the importance of an individual's awareness of their impairments and emotional factors as these will influence the neurorehabilitation process (Dams-O'Connor and Gordon, 2013). This echoes Cicerone et al. (2005) in their systematic review where they note that psychosocial interventions may facilitate the effectiveness of treatments directed at specific cognitive impairments. Evans & Wilson (1992) found a reduction in symptoms of anxiety and depression when a group programme for individuals with an ABI included fostering of social support, in addition to memory strategies. Another study by Tiersky et al., (2005) looked at the effects of a rehabilitation programme offering psychotherapy and cognitive rehabilitation compared to cognitive rehabilitation alone. The

group that received both psychotherapy and cognitive rehabilitation showed significantly improved emotional functioning (Tiersky et al., 2005).

A holistic approach to neuropsychological rehabilitation has progressively been recognised as an important form of rehabilitative care for individuals with moderate to severe traumatic brain injury (Prigatano, 2013). Ben-Yishay & Prigatano (1990) provide a model of hierarchical stages through which the patient must work in rehabilitation. Holistic programmes tend to work through these hierarchical stages, which include: (i) increasing the individual's awareness of what has happended to him/her; (ii) increasing acceptance and understanding of what has happened; (iii) providing strategies or exercises to reduce cognitive problems; (iv) developing compensatory skills; and (v) providing vocational counselling (Wilson, 2017). Holistic programmes include both group and individual therapy (Wilson, 2017). One of the best-known holistic programmes is that of George Prigatano (1986; Wilson, 2017). Prigatano's centre in Oklahoma City was greatly influenced by Ben-Yishay and he later he took it to Phoenix, Arizona. Prigatano went on to influence Anneliese Christensen, who introduced a similar centre in Denamark in 1995 (Christensen & Teasdale, 1995), as well as Wilson and her colleagues who opened the Oliver Zangwill Centre in Cambridgeshire, England in 1996 (Wilson, 2017).

A holistic approach has been shown to improve community functioning (Gordon et al., 2006) and Prigatano (1999) suggests that neuropsychological rehabilitation is likely to fail if we do not deal with the emotional issues. Mellon, Brewer, Hall, Horgan, Williams & Hickey (2015) make the case that neuropsychological rehabilitation post-stroke is required to meet the burden of post-stroke cognitive impairment.

Comprehensive holistic rehabilitation models as described by Wilson (2002), Ben-Yishay & Prigatano (1990) and Sohlberg & Mateer (2001) have strongly inspired cognitive rehabilitation programmes around the world (Becker, Kirmessa, Tornas & Løvstada, 2014).

There is an increasing body of evidence from controlled trials to support the efficacy of comprehensive holistic brain injury rehabilitation programmes for individuals beyond the acute rehabilitation phase (Ownsworth, Fleming, Shum, Kuipers, & Strong, 2008). The Brain Injury Interdisciplinary Special Interest Group (BI-ISIG) of the American Congress of Rehabilitation Medicine (ACRM) has provided up-to date reviews of the state of the art in cognitive rehabilitation research and this has been "tremendously inspiring and trend-setting" (Becker et al. 2014, p.88). The BI-ISIG conclude that given their effectiveness in improving community integration, functional independence, and productivity, even many years post injury, comprehensive, holistic rehabilitation programs should be considered practice standard following moderate and severe TBI (Cicerone, Langenbahn, Braden, Malec, Kalmar, Fraas et al., 2011). However, it should be noted that due to their comprehensive nature, they may not be financially feasible in some rehabilitation settings (Ownsworth et al., 2008).

Becker et al. (2014) argue that rehabilitation providers can be faced with the challenge of providing comprehensive, holistic rehabilitation programmes or interventions for distinct cognitive impairments (e.g. for attention, memory, aphasia, and executive function), with both approaches supported by evidence (Cicerone et al., 2000, 2005, 2011). Research suggests that many cognitive skills are functionally interrelated, providing support for comprehensive neurorehabilitation (Dams-O'Connor & Gordon, 2013). However, broad, holistic interventions may run the risk of lacking the specificity of highly targeted programmes and interventions targeting distinct functions might not adequately address the broad emotional, psychosocial and vocational needs of patients (Becker et al., 2014). A cognitive rehabilitation unit in Sunnaas Rehabilitation Hospital, Norway integrates interventions targeting specific functions into holistic programmes, as well as offering specified programmes targeting impairments of distinct cognitive functions (Becker et al.,

2014) and the authors argue for further research to investigate the optimal manner of offering and combining these two approaches.

Particular cognitive rehabilitation therapy techniques are recommended following deficits in specific cognitive domains (Laatsch et al., 2004). For example, repetitive practice with graded visual stimuli is recommended when the focus of therapy is sustained attention and visual scanning (Sohlberg & Mateer, 2001; Robertson, Manly, Andrade, Baddeley & Yiend, 1997), whereas a focus on compensative memory strategies is recommended for rehabilitation of memory (Cicerone et al., 2000; Cicerone, 2002). In relation to rehabilitation of expressive language skills, both restorative therapy and compensative strategy training is recommended depending on the specific type of language deficit (Cicerone et al., 2000). Virtual reality technologies are starting to be used as assessment and treatment tools in cognitive rehabilitation and it seems likely that virtual reality treatment approaches will become the norm in neuropsychology and rehabilitation (Wilson, 2013).

A meta-analysis conducted by Rohling et al. (2009), found sufficient evidence for the effectiveness of attention training after TBI and for language and visual-spatial training for symptoms of stroke. Cappa, Benke Clarke, Rossi, Stemmer, van Heugten et al. (2011) and Cicerone et al. (2011) argue for cognitive rehabilitation programmes to include evidence-based interventions on distinct cognitive domains that can be regarded as effective (e.g. attention training or visual scanning training), given that programmes can be underspecified with regard to their approach to distinct cognitive functions.

The challenge for cognitive rehabilitation is to improve the ability to participate in meaningful activities through transfer (for example from a rehabilitation centre to home) and generalisation (to everyday activities; Krasny-Pacini et al., 2014). Based on the International Classification of Functioning, Disability and Health (WHO, 2001), which emphasises the dynamic interaction between health, the environment and personal factors, rehabilitation

outcomes following brain injury may be optimal when interventions address environmental factors that have a facilitatory or inhibitory effect (Keysor, Jette, Coster, Bettger & Haley, 2006).

There is evidence that individuals who are many years post brain injury can still benefit from cognitive rehabilitation. High et al., (2005) reviewed studies of post-acute rehabilitation and found that several studies demonstrated that persons starting post-acute rehabilitation more than a year post-injury show significant functional gains, suggesting that it is 'never too late' for cognitive rehabilitation. Similarly, Tornås, Løvstad, Solbakk, Evans, Endestad, Hol et al. (2016), in a randomised controlled trial, found that executive dysfunction can be improved even years after ABI. In relation to the effectiveness of inpatient rehabilitation versus post-acute rehabilitation, High et al. (2005) concluded that persons with TBI make functional gains while participating in either inpatient rehabilitation or comprehensive post-acute rehabilitation programmes and functional gains are largely retained over time.

Studies have found that outcome following brain injury may be influenced by injury severity as well as demographic factors including age, gender, and pre-injury education and employment (Ponsford et al., 2008). Green, Colella, Christensen, Johns, Frasca, Bayley et al. (2008) suggest that age is probably the most important of these moderator variables. The influence of pre-injury education relates to theories of cognitive and brain reserve capacity, which suggest that vulnerability to neurological insults varies as a function of pre-injury functioning and brain integrity (Dennis, Yeates, Taylor, & Fletcher, 2007). A study by Malec, Goldstein & McCue (1991) found that for TBI patients, better training outcome for memory was correlated with longer time since injury (range of 12–204 months) but not with age or education.

In terms of resilience and adjustment post brain injury, there has been a shift in interest from characterising risk factors for poor outcome, to investigation of protective factors that contribute to good adjustment (Becker et al., 2014). Sarre, Redlich, Tinker, Sadler, Bhalla & McKevitt (2013) highlight that research on such protective factors in the ABI population is sorely needed.

We have very little knowledge of how to treat cognitive impairments cost effectively, however this is an issue that is becoming increasingly important for neuropsychologists and other clinicians (Worthington, Ramos & Oddy, 2017). Although neuropsychological rehabilitation can appear to be expensive in the short term, it is often cost-effective in the long-term and an important group of people who need to be convinced of the value of rehabilitation are healthcare purchasers (Wilson et al., 2017). An argument in favour of the provision of neuropsychological rehabilitation for individuals with brain injury is that people who do not receive rehabilitation can ultimately become a much larger financial burden upon the state and on their families if rehabilitation funding is not provided (Wilson et al., 2017).

Several studies have investigated the cost-effectiveness of rehabilitation programmes, for example Wood, McCrea, Wood & Merriman (1999) demonstrated that a neurobehavioural rehabilitation programme for patients with severe brain injury results in substantial savings of 'hours of care' when comparing pre- and post-rehabilitation costs. Wood et al. (1999) calculated a notional saving in lifetime care costs of between £0.5 million and £1.1 million depending on how soon after injury rehabilitation commenced (with higher savings for those admitted within two years of injury). A study by Wilson & Evans (2003) found that use of an electronic pager costing approximately $90 per month resulted in the user reducing his daily support from two carers over 24 hours to one carer for 12 hours. Diller & Ben-Yishay (2003) have also presented findings that support the argument that the holistic approach model to brain injury programmes is cost effective.

1.5.1. Rehabilitation of Memory Deficits

Rehabilitation of memory problems tends to focus on treating common memory complaints that impact on everyday functioning, typically arising from deficits in new learning and prospective memory (Parker, Haslam, Fleming & Shum, 2017). The efficacy of memory rehabilitation in the TBI population has been supported in several reviews (e.g., Cicereone et al. 2005; Cicerone et al., 2011; Cicerone et al., 2019; Rees, Marshall, Hartridge, Mackie, & Weiser, 2007). A meta-analysis conducted by Rohling, et al. (2009) concluded that "the results for memory rehabilitation are mixed and weak" (pg. 33). However, a more recent meta-analysis conducted by Elliott & Parente (2014) showed that memory rehabilitation was an effective therapeutic intervention, especially for stroke patients and for working memory as a treatment domain. Results also indicated that significant memory improvement occurred spontaneously over time (Elliott & Parente, 2014).

Rehabilitative approaches for managing memory impairments post brain injury can be generally divided into compensatory strategies and restorative techniques (Velikonja et al., 2014). Compensatory strategies include the use of the residual cognitive strengths of individuals to minimise the functional impact of their memory impairment in the course of performing daily tasks and include both internal and external strategies. Systematic reviews of the cognitive rehabilitation literature, conducted by Cicerone et al. (2005) and Cappa et al. (2005), concluded that the use of strategies that compensate for memory deficits are the most effective approach to managing memory problems and increasing everyday functioning following brain injury. A more recent systematic review by Cicerone et al. (2011) recommended only memory strategy training, because the effectiveness of other types of memory remediation have yet to be verified in methodologically sound controlled group studies in various clinical populations. Compensatory strategies were found to have evidence

of “probable effectiveness” for persons with moderate or severe memory impairment after TBI or stroke (Cicerone et al., 2011).

INCOG consists of an international team of researches and clinicians formed to develop recommendations for the management of impairments in memory post brain injury. INCOG recommendations for rehabilitation of memory impairments support the integration of internal and external compensatory strategies implemented using appropriate instructional techniques that consider functional relevance and important patient characteristics (Velikonja et al., 2014). These recommendations are supported by research which found improvements in memory functioning when internal and external memory strategies were combined and incorporated into structured training programmes (Ownsworth & McFarland, 1999; Sohlberg, Kennedy, Avery, Coelho, Turkstra, Ylvisaker & Yorkston, 2007; Wilson, 2009). Parker et al. (2017) suggest that incorporating psychoeducation on memory and everyday factors related to its function into compensatory training programmes may provide additional benefits.

Internal compensatory strategies involve an increase in conscious effort during the encoding phase of memory processing, by increasing an individual’s ability to monitor his or her task performance (Velikonja et al., 2014). Internal strategies include instructional and/or metacognitive strategies, for example, visualisation/ visual imagery, repeated practice, retrieval practice, PQRST (Preview, Question, Read, Self-Recitation, Test) self-cueing, self-generation and self-talk (Velikonja et al., 2014). The use of internal strategies have proved useful in enhancing memory for specific information in individuals with a mild impairment, however those with severe memory impairment may not use them spontaneously outside clinical settings (Velikonja et al., 2014). A systematic review by O’Neil-Pirozzi, Kennedy, and Sohlberg (2016) suggested that internal memory strategy use may benefit individuals with traumatic brain injury, and clinicians should consider internal memory strategy instruction as part of intervention plans.

External memory strategies include the use of environmental strategies (e.g. labels, signs and routines) and aids (e.g. diaries, checklists, notebook, whiteboard and personal electronic devices) (Parker et al., 2017). Other terms for external aids include cognitive orthoses, cognitive prosthetics, and assistive technology (Cole, 1999; Kirsch, Levine, Fallon-Kreuger & Jaros, 1987). A randomised control trial conducted by Shum, Fleming, Gill, Gullo, & Strong (2011) involved a six-session compensatory training programme for managing prospective memory deficits in individuals with an ABI. The programme focused on external memory strategies to improve diary use. The programme was found to be effective in increasing spontaneous strategy use and resulted in greater daily diary use (Shum et al., 2011). A meta-analysis by Jamieson, Cullen, McGee-Lennon, Brewster & Evans (2014) found that the use of prosthetic technology can improve performance on everyday tasks requiring memory. Learning to use external memory aids can be challenging, particularly for those with a severe brain injury, and therefore the use of environmental supports and reminders is recommended for those with severe injuries (Velikonja et al., 2014). One of the benefits of external strategies is that they can be easily incorporated into individuals' lives and the benefits of training in a clinical setting can generalise to community settings (Shum et al., 2002). The evidence most strongly supports the use of prospective memory aids such as pagers, smartphones, smartwatches or voice recorders (Lesniak, Mazurkiewicz, Iwański, Szutkowska-Hoser & Seniów, 2018; Parker et al., 2017). Use of these electronic aids have been found to improve day-to-day functioning for individuals with memory impairments (Lannin, Carr, Allaous, Mackenzie, Falcon & Tate, 2014; McDonald, Haslam, Yates, Gurr, Leeder & Sayers, 2011). A systematic review conducted by Mahan, Rous & Adlam (2017) found that prospective memory can be improved by using simple reminder systems and performance can be generalised to everyday prospective memory functioning.

O'Neill, Moran & Gillespie (2010) report on the use of voice-mediated assistive technology for cognition called Guide. The technology provides verbal prompts and responds to verbal feedback, thus scaffolding task performance. Use of Guide resulted in a significant reduction of safety critical errors and omitted steps for amputees with cognitive impairment putting on their prosthetic limbs (O'Neill et al., 2010). Individuals may also benefit from non-electronic aids such as diaries or organisers, however they need to be properly trained in using these aids and be supervised by caregivers (Shum, et al., 2011). Velikonja et al. (2014) report that there is a general consensus that the use of external compensatory memory strategies is associated with reduced functional problems in daily living for individuals with memory problems caused by ABI. Reviews highlight that the evidence base remains relatively small, with very few good quality RCTs having been conducted.

The extent to which internal and external memory strategies may be effective depends on a number of factors. Internal strategies are only likely to be effective in individuals with sufficient motivation, self-awareness and executive function to be able to identify the situations in which they are applicable and follow through with using them (Velikonja et al., 2014). This would suggest that they are more appropriate for use in individuals with mild to moderate memory impairments. Those with more severe memory impairments are more likely to benefit from external strategies, which will also be appropriate for people with mild-moderate memory problems (Velikonja et al., 2014). In relation to the mode of delivery of memory strategy training, individual interventions seem to be the most frequently used, but the use of group-based interventions is also recommended (Lesniak et al., 2018).

Instructional strategies can be used as part of memory rehabilitation, to enhance learning. These include errorless learning, spaced retrieval, vanishing cues, chaining, visual imagery and verbal elaboration, with errorless learning and spaced retrieval considered to be the most effective and commonly used (Clare & Jones, 2008; Ehlhardt, Sohlberg, Kennedy

Coelho, Ylvisaker, Turkstra & Yorkston, 2008; Grandmaison & Simard, 2003; Haslam, Hodder & Yates, 2011). Piras, Borella, Incoccia & Carlesimo (2011) have indicated that spaced retrieval and use of vanishing cues are "potentially effective" rehabilitation methods, based on currently available scientific evidence. Errorless learning (EL) is a teaching technique whereby people are prevented, as far as possible, from making mistakes while they are learning a new skill or acquiring new information and is an important principle in memory rehabilitation (Wilson, 2013). By preventing the learner from making errors, the potential for interference from competing memory traces is reduced, maximising reinforcement of the correct response (Wilson et al., 2013). The basic principle advocated in spaced retrieval is repeated and spaced rehearsal of information to be learned. (Haslam et al., 2011).

Errorless learning has been found to improve memory performance in a variety of tasks, predominantly in ABI (e.g. word lists, face-name associations, general knowledge, and learning to use an electronic organiser; Evans, Wilson, Schuri, Andrade, Baddeley, Bruna, Canavan et al., 2000; Fish, Manly, Kopelman & Morris, 2015; Wilson et al., 1994, 2001). Clare & Jones (2008) report that errorless learning seems to be more beneficial for individuals with severe memory impairment, however Cicerone et al. (2011) note that errorless learning in severely injured persons is often limited in terms of transfer to novel tasks or reduction in overall functional memory.

Restorative techniques, on the other hand, aim to improve the specific impaired cognitive function through repeated exercises or massed training trials (Lebowitz, Dams-O'Connor & Cantor, 2012). In recent years, computer-based restorative rehabilitation techniques have been developed to remediate cognitive impairments following brain injury (Lebowitz et al., 2012). A literature review conducted by Gontkovsky, McDonald, Clark & Ruwe (2002) suggested that computer programmes integrating hierarchically based training,

in which task difficulty is increased as more basic skills are demonstrated, can be more effective. Gains can be confined to trained tasks, although there is also some evidence for changes in neuroimaging (Fernandez, Bringas, Salazar, Rodriguez, Garcia & Torres, 2012; Ruff, Crouch, Troster, Marshall, Buchsbaum, Lottenberg et al., 1994). A review conducted by Dou, Man, Ou, Zheng & Tam (2006) suggests that computer-assisted memory training is most likely to be effective if sessions are therapist-driven, train basic memory skills, and integrate those skills into ecologically valid tasks, tailored to the person with brain injury and generalised into practical tasks.

Research into the use of computerised adaptive training to improve working memory has attracted extensive funding and research efforts (Fish & Manly, 2017). In a series of studies, Klingberg and others at the Karolinska Institute in Stockholm demonstrated that intensive and adaptive working memory training resulted in an increase in working memory capacity, transfer to untrained tasks, and an increased fronto-parietal activation level shown using functional magnetic resonance imaging (fMRI) that correlated with the increase in working memory capacity (van Heughten, Ponds & Kessels, 2016). A meta-analysis conducted by Weicker, Villringer & Thone-Otto (2016) found that working memory training produces long-lasting beneficial effects for individuals with an ABI.

CogMed training involves an individual progressively and systematically working to improve their working memory and/or attentional skills (Prigatano, 2013). Westerberg, Jacobaeus, Hirvikoski, Clevberger, Östensson, Bartfai & Klingberg (2007) and Lundqvist, Grundström, Samuelsson, and Rönnberg (2010) administered CogMed training to individuals with an ABI and observed improvements on digit span and a spatial span task. However both of these tasks were part of the training programme and therefore the results could be attributed to training effects (Lindelov, Dall, Kristensen, Aagesen, Olsen, Snuggerud & Sikorska, 2016). A prospective cohort study conducted by Johansson & Tornmalm (2012)

used a computerised training programme called Cogmed QM combined with coaching by therapists, education regarding the functional integration of strategies, and peer support. The programme was found to be effective in improving functioning on daily tasks in a sample of participants with moderate to severe memory impairments (Johansson & Tornmalm, 2012), thus demonstrating the benefit of combining computer training with instructional and compensatory strategies to bring about an improvement in performance on functional tasks.

Opinions vary in relation to working memory training. Although recent meta-analyses show strong evidence for generalisation to everyday functioning (Au, Buschkuehl, Duncan & Jaeggi 2016; Spencer-Smith & Klingberg, 2015), a recent meta-analytic review by Melby-Lervåg and Hulme (2013) evaluated 23 working memory training studies and concluded that only short-term improvements in working memory, but no transfer effects on other cognitive domains were produced by the interventions and they advise against the use of working memory training. Other recent meta-analyses have shown limited transfer to everyday functioning (Dougherty, Hamovitz & Tidwell, 2016; Melby-Lervag, Redick & Hulme, 2016). Fish & Manly (2017) suggest that caution should be exercised in the use of computerised working memory training, due to a lack of consistent evidence that training-related benefits generalise to everyday functions. Current guidelines advocate the use of computer-based training programmes as an adjunct to evidence-based instructional and compensatory strategies (Nadar & McDowd, 2010; Velikonja et al., 2014).

1.5.2. Rehabilitation of Attention Deficits

The cognitive approaches used to treat attentional deficits either involve direct training through repetition on attention-specific exercises, or the teaching of compensatory strategies to promote functional adaptation (Park & Ingles, 2001). Historically, remediation of attention deficits in brain injury has utilised a restorative drill and practice approach (Vakili &

Langdon, 2016). The underlying rationale for this approach is that practice on selected exercises promotes recovery of damaged neural circuits and restores function in the impaired attentional processes themselves (Park & Ingles, 2001).

The effectiveness of post-ABI attention rehabilitation remains unclear with previous meta-analyses (Park & Ingles, 2001; Rohling et al., 2009) producing conflicting results (Virk, Williams, Brunsdon, Suh & Morrow, 2015). A Cochrane Review by Loetscher & Lincoln (2013) which investigated cognitive rehabilitation for attention deficits following stroke, suggests that there may be a short-term effect on attentional abilities, but further studies are needed to assess longer-term effects and to measure attentional skills in daily life. A meta-analysis conducted by Rohling et al. (2009) found sufficient evidence for the effectiveness of attention training after TBI. The findings of previous meta-analyses were largely based on uncontrolled or non-randomized studies, the majority of which were conducted over fifteen years ago, representing a significant gap in the literature (Virk et al., 2015). Cicerone et al. (2000, 2005, 2011) reviewed the literature on cognitive rehabilitation for attention deficits following TBI and concluded that while attention training benefits patients beyond the specifically trained task, the effects may be small and/or remain relatively task-specific. The need to examine the impact of attention training on other cognitive functions, such as executive functions, and activities of real-world daily living, was highlighted by the researchers.

INCOG, an international group of experts, published recommendations for interventions to address deficits in attention, based on a systematic review of the evidence (Ponsford, Bayley, Wiseman-Hakes, Togher, Velikonja, McIntyre, Janzen et al., 2014). The main recommendations include: (1) metacognitive strategy training applied to personally and functionally relevant tasks; (2) dual task training on individually relevant tasks; (3) Cognitive Behavioural Therapy (CBT) to address interactions between emotion and attention; (4)

screening and treatment of sleep disorders that exacerbate attentional problems; (5) adapting the environment and tasks to minimise their attentional demands and maximise functioning; (6) methylphenidate effective as a short-term intervention for improving processing speed.

A common method of rehabilitation for attentional deficits has been computer-based training programmes which is based on the restorative approach. One such programme, Attention Process Training (APT; Sohlberg & Mateer, 2011), is a hierarchical, multilevel direct attention training computer programme designed to remediate attention after brain injury (Dymowski, Ponsford & Willmott, 2016). Another frequently studied training package is AIXTENT (Sturm, Orgass & Hartje, 2001), which focuses on alertness, vigilance, selective attention and divided attention. In a meta-analysis of 30 studies of attention retraining after TBI, Park and Ingles (2001) found that pre–post studies demonstrated large effect sizes which tended to be significant, with the authors attributing the training gains to practice effects or acquisition of specific skills. Guidelines for attention training following TBI do not recommend reliance on repetition of computerised attention tasks due to limited evidence of generalisation to everyday attentional abilities (Bayley, Teasell, Marshall, Cullen, Colantonio, Kua & ABIKUS Project Expert Panel, 2007; Ponsford, Bayley et al., 2014). Some researchers have suggested that attention training may be helpful in conjunction with clinician-guided metacognitive training (Cicerone et al., 2011; Sohlberg et al., 2003; Fish, 2017). Metacognitive strategy training, environmental modification and use of assistive technology represent alternative or complementary treatments to computer-based attention training (Dymowski et al., 2016). Two RCTs (Couillet, Soury, Lebornec, Asloun, Joseph, Mazaux & Azouvi, 2010; Evans et al., 2009) identified benefits from brief periods of training in dual tasking, however evidence of generalisation is lacking.

Medications such as Methylphenidate have shown some promise in treating attention deficits (Rees, 2007), however there is uncertainty regarding the frequency and nature of their

adverse effects in the long-term and therefore cognitive rehabilitation has been increasingly highlighted as a potential adjuvant or alternative treatment (Virk et al., 2015). As discussed above, Methylphenidate is recommended by INCOG as a short-term intervention for improving processing speed.

Mindfulness-based cognitive therapy has been shown to impact upon attention in other populations (Jha, Morrison, Dainer-Best, Parker, Rostrup & Stanley, 2015; Tang, Ma, Wang, Fan, Feng, Lu, Yu et al., 2007). However, these studies have not incorporated active placebo conditions and therefore further research is required in this area, including research involving neurolgical populations (Fish, 2017).

Vakili & Langdon (2016) report on a novel eight-week cognitive rehabilitation programme developed to remediate attention deficits in adults with a TBI, incorporating the use of action video game playing and a compensatory skills programme. Results showed improvements in the treatment group, but not the control group, for performance on the immediate trained task (i.e. the video game) and in non-trained measures of attention and quality of life. This study shows the potential for the use of novel approaches to the remediation of attention deficits.

Several studies (Gray, Robertson, Pentland, & Anderson, 1992; Niemann, Ruff, & Baser, 1990; Sohlberg & Mateer, 1987; Sturm, Willmes, Orgass, & Hartje, 1997) have demonstrated that individuals with executive dysfunction benefit from interventions to improve attention (Dams-O'Connor & Gordon, 2013), supporting the idea that attention, memory and executive functions are intimately related (Stuss, Shallice, Alexander, & Picton, 1995).

1.5.3. Rehabilitation of Executive Functioning Deficits

The main treatment approaches for executive functioning difficulties described in the literature can be classified as interventions with the aim of (1) restoring or re-training executive functions; (2) compensating for executive impairments through the use of internal or external strategies; (3) promoting modification of the environment or behaviour by working with carers, family and friends and behaviour modification techniques; and (4) pharmacological treatments (Miotto, Evans, Souza de Lucia & Scaff, 2009). Evidence for the effectiveness of interventions in each of these areas is rather limited (Miotto, et al., 2009). Traditionally, cognitive rehabilitation methods were aimed at restoration of function lost by brain damage, involving repeated practice or stiumlation, for example through computer exercises. However, generalisation of treatment effects to daily life has hardly been demonstrated (Cicerone et al., 2011). A Cochrane Review conducted by Chung, Pollock, Campbell, Durward, & Hagen (2013) found insufficient high-quality evidence to reach any generalised conclusions about the effect of cognitive rehabilitation on executive function, or other secondary outcome measures.

Sohlberg & Mateer (2001) have proposed different therapeutic approaches for managing dysexecutive symptoms. One approach is for individuals to get cues and prompts to perform the required behaviours, with these cues and prompts gradually diminishing over time until the individual is able to perform the required behaviours without assistance. Support for this approach has been provided by Burke, Zencius, Wesolowski & Doubleday (1991) and Giles, Ridley, Dill & Frye (1997) who found it effective for patients carrying out work- or self-care related behaviours.

Another approach proposed by Sohlberg & Mateer (2001) is the learning of metacognitive strategies or self-instructional training. In a systematic review conducted by Kennedy et al. (2008) investigating interventions for executive function after TBI, there was

a similarity found between intervention approaches across studies, with 10 studies containing several features of metacognitive strategy instruction (Burke et al., 1991; Cicerone & Giacino, 1992; Cicerone & Wood, 1987; Fasotti, Kovacs, Eling, & Brouwer 2000; Levine, Robertson, Clare, Carter, Hong, Wilson et al., 2000; Rath et al., 2003; Suzman, Morris, Morris & Milan 1997; Turkstra & Flora, 2002; von Cramon et al., 1991; Webb & Gluecauf, 1994). The approaches were similar in their use of steps that included self-monitoring, self-recording of performance, making strategy decisions based on goals and adjusting or modifying the plan based on the self-assessment and/or external feedback. The systematic review conducted by Kennedy et al. (2008) found a "substantial amount of compelling research evidence that training individuals with TBI using step-by-step metacognitive strategy instruction will improve problem solving, etc. for personally relevant activities or problem situations" (p. 292). The majority of participants in the studies reviewed were young and middle-aged adults in chronic stages of disability as a result of TBI, indicating that these individuals are good candidates for this type of intervention. There was less evidence to support the maintenance of activity outcomes after the completion of the intervention and therefore further research in this area is warranted.

One of the best known and most extensively studied metacognitive approaches is Goal Management Training (GMT; Krasny-Pacini et al., 2014) which incorporates self-instructions aimed at strengthening the individual's ability to interrupt and control ongoing behaviour (Tornås et al., 2016). Promising results have been reported for GMT (Levine, Schweizer, O'Connor, Turner, Gillingham, & Stuss et al., 2011). GMT adopts a metacognitive approach (i.e. 'thinking about your thinking') which includes self-awareness, self-monitoring and self-control of cognition while performing an activity (Kennedy et al., 2008). GMT promotes a mindful approach to completing complex everyday activities by raising awareness of attentional lapses and reinstating cognitive control when behaviour

becomes incompatible with intended goals (Levine et al., 2011). Initially the intervention consisted of one hour of instructions but it was then developed further into a 14-hour GMT programme ready for group rehabilitation in clinical settings (Levine et al., 2011). In an RCT involving patients with a TBI, Levine et al. (2000) found GMT was associated with significant gains on everyday paper-and-pencil tasks designed to mimic tasks that are problematic for patients with goal neglect. These effects were significant in spite of the relatively brief intervention (1 hour of training). A meta-analysis conducted by Stamenova & Levine (2018) found that GMT is an effective intervention, leading to moderate improvements in executive functions that are usually maintained at follow-up. Levine et al. (2000) also used GMT with a postencephalitic patient, who improved her meal-preparation abilities based on naturalistic observation and self-report measures. Following a review, Krasny-Pacini et al., (2014) concluded that the effectiveness of GMT was greater when it was combined with other interventions.

Promising results have also been reported for interventions involving problem solving treatment (PST; Miotto et al., 2009; Rath, Simon, Langenbahn, & Sherr, 2003; von Cramon, Matthes-von Cramon, & Mai, 1991) which was developed by Von Cramon and Matthes-von Cramon (1994). Systematic reviews conducted by Cicerone and colleagues (Cicerone et al., 2000; 2005) concluded that there was sufficient research evidence to make interventions for problem solving a practice guideline when the intervention used functional activities and everyday situations. PST involves teaching a general strategy to solve problems, with steps including (1) problem identification and analysis; (2) collection of information and generation of hypotheses; and (3) evaluation of solutions. Von Cramon and Matthes-von Cramon (1994) reported that individuals with TBI were able to apply this strategy in their work situations.

Spikman, Boelen, Lamberts, Brouwer & Fasotti (2010) report on a treatment programme for executive function deficits where GMT was combined with PST and with a general planning approach. The treatment resulted in significant improvements on several indicators of executive functioning in daily life and these improvements lasted over time (Spikman et al., 2010).

Metacognitive approaches appear to have the best level of evidence in relation to improving executive functioning (Cicerone et al., 2011; Kennedy et al., 2008; Rohling et al., 2009) with some studies suggesting that interventions using GMT combined with other training methods are more effective than GMT-alone interventions (Novakovic-Agopian, Chen, Rome, Abrams, Castelli, Rossi, et al., 2011; Miotto et al., 2009; Spikman et al., 2010). Unfortunately, not much is known about the best dose of treatment and for which patients GMT is more effective (Krasny-Pacini et al., 2014).

INCOG, the international group of experts, strongly recommend intervention programmes that incorporate metacognitive strategies for planning and problem-solving focusing on everyday problems and functional outcomes, for the management of executive function deficits following brain injury (Tate, Kennedy, Ponsford, Douglas, Velikonja, Bayley & Stergiou-Kita, 2014). Strategy treatment may not be suitable for all individuals with brain injury, particularly those with severe injuries and limited self-awareness (Tate et al., 2014). These individuals will need environmental management and external structure such as aids (e.g. checklists, automatic alerts or mobile phones; Spikman, 2017).

1.5.4. Rehabilitation of Psychosocial Deficits

Cognitive behavioural therapy (CBT) is a well established psychotherapeutic approach for managing psychological distress post brain injury (Ownsworth & Gracey, 2017). One of its major strengths has been the development of clinically relevant theories for depression,

anxiety, panic, obsessive-compulsive disorders and phobias (Wilson et al., 2017). Mateer & Sira (2006) suggest that CBT is suitable for improving coping skills, helping clients to manage cognitive difficulties, as well as addressing more generalised anxiety and depression post brain injury. A review conducted by Waldron, Casserly & O'Sullivan (2013) reported a large average effect size (1.15) for studies targeting the treatment of depression with CBT and a large average effect size (1.04) for studies targeting the treatment of anxiety with CBT.

The field of CBT has evolved to incorporate novel interventions such as mindfulness-based cognitive therapy (MBCT; Teasdale, Segal, Williams, Ridgeway, Soulsby & Lau, 2000). In more recent years, a 'third wave' of cognitive behavioural therapies have been developed, with Acceptance and Commitment Therapy (ACT) being one of the most established (Hayes, 2002).

Gracey, Evans & Malley (2009) propose a Y-shaped cognitive-behavioural model which represents the relationship between change processes and outcomes in therapy. A central notion of the Y-shaped model is that adjustment to ABI can lead to personal and social discrepancies which can be experienced as a threat to self. This in turn can trigger maladaptive coping reactions, such as denial of impairments and the avoidance of or withdrawl from activities that reduce threat in the short term (Gracey et al., 2009). CBT interventions have been used for people with ABI targeting anxiety, acute stress, anger, insomnia and fatigue, and depression (Ownsworth & Gracey, 2017). Given the challenges that a person with an ABI may have, such as reduced self-awareness or executive function deficits, it is important that the therapist adapts the therapy to meet individual clients' needs (Judd & Wilson, 2005). Practical adaptations may also be necessary such as shorter sessions, repetition, written summaries and involvement of significant others in planning and performing homework activities (Ownsworth & Gracey, 2017).

The evidence supporting CBT interventions for people with ABI is largely mixed, however there is growing evidence that CBT interventions can improve psychological wellebing (Ownsworth & Gracey, 2017). There is a need to evaluate the active components of effective CBT interventions to distinguish the benefits of behavioural components (e.g. behavioural activation, relaxation) from cognitive techniques (Ownsworth & Gracey, 2017). A Cochrane Review conducted by Soo & Tate (2007) found some evidence for the effectiveness of CBT for treatment of acute stress disorder following mild TBI and CBT combined with neurorehabilitation for targeting general anxiety symptomatology in people with mild to moderate TBI. A recent Cochrane Review found insufficient evidence to guide the treatment of anxiety after stroke (Knapp, Campbell Burton, Holmes, Murray, Gillespie, Lightbody et al., 2017) and a Cochrane Review found no evidence for the benefit of psychotherapy in the treatment of depression after stroke (Hackett, Anderson, House & Xia, 2008).

Relaxation strategies can be used successfuly to reduce anxiety in the general population and have been applied to individuals with brain injury (Twamley, Jak, Delis, Bondi, & Lohr, 2014). Such strategies include controlled breathing techniques (Lewis, Farewell, Groves, Kitchiner, Roberts, Vick et al., 2017; Tubridy, 2003; Twamley et al., 2014; White, 2000) and grounding relaxation exercises (Lewis et al., 2017; Twamley et al., 2014). Grounding techniques are frequently used for people with trauma and Post Traumatic Stress Disorder (PTSD). Simple controlled breathing techniques, combined with diaphragmatic breathing (or abdominal breathing) can be a useful technique to promote a sense of immediate short-term control for a person who is experiencing anxiety (White, 2000). A study by Chen, Huang, Chien & Cheng (2017) which looked at the effectiveness of a diaphragmatic breathing relaxation training programme, found that the experimental group achieved significant reductions in anxiety scores as well as reductions in breathing and heart

rate over the 8-week training period. Lewis et al. (2017) investigated the effectiveness of an internet-based guided self-help programme for posttraumatic stress disorder (PTSD) which used both controlled breathing techniques and grounding relaxation exercises. They found that the programme resulted in significant improvements for the intervention group on depression, anxiety, PTSD and functional impairment, and improvements were maintained at one month follow-up. Twamley et al. (2014) included abdominal breathing and grounding exercises as part of a 12-week intervention for individuals with TBI. They found small to medium effect sizes favouring the intervention for the reduction of posttraumatic stress disorder and depressive symptom severity (Twamley et al., 2014).

1.5.5. Management of Fatigue

Fatigue is difficult to define, operationalise and measure, and therefore creates a challenge in relation to the development of evidence-based interventions (Malley, 2017). A systematic review conducted by Cantor et al. (2014) concluded that there is insufficient evidence to recommend or contraindicate any treatments for fatigue post-TBI and the same challenge arises in relation to fatigue post-stroke (Kutlubaev & Mead, 2012).

Ponsford, Schönberger, & Rajaratnam (2015) propose that to alleviate fatigue, it is important to address anxiety, depression, and daytime sleepiness as these factors are associated with, and may exacerbate, fatigue. Similarly, Wu et al. (2014) conclude that because post-stroke fatigue is associated with depressive symptoms, anxiety, poor coping, loss of control, emotional, and behavioural symptoms, that these factors are potential targets for treatment of post-stroke fatigue. Ponsford et al. (2015) call for longitudinal research in this area in order to better understand these various factors and how they relate to each other.

Individuals suffering from fatigue post brain injury may not be aware of their reduced capacity for physical and/or mental activity which can be due to anosognosia, interoceptive

challenges or dysexecutive syndrome (Malley, 2017). Therefore, increasing awareness of indicators for fatigue may be a necessary component of fatigue mamagement. The effectiveness of support-group based interventions has been supported by some researchers (Clarke, Barker-Collo & Feigin, 2012; Cooper, Reynolds & Bateman, 2009; Flinn & Stube, 2010).

A pilot RCT conducted by Sinclair, Ponsford, Taffe, Lockley, & Rajaratnam (2014) found that blue light therapy can reduce fatigue and daytime sleepiness. Cognitive behavioural therapy has also been found to be effective in addressing fatigue and sleep disturbance (Nguyen, McKay, Wong, Spitz, Mansfield, Williams et al., 2017). In their systematic review, Cantor and colleagues (2014) recommend cognitive behavioural therapy as promising but requiring further study. Zedlitz, Rierveld, Geurts, & Fasotti (2012) conducted a multicentre RCT with stroke patients comparing 12 weeks of cognitive therapy with cognitive therapy augmented with graded activity training (COGRAT). Both groups reported reduced fatigue and the COGRAT group had better outcomes on the primary fatigue measure (Zedlitz et al., 2012).

In a review conducted by Nadarajah & Goh (2015) they found that single-disciplinary management for post-stroke fatigue was rarely successful and that evidence suggests that approaches which incorporate both physical and psychological interventions may be beneficial. A study conducted by Kolakowsky-Haynera, Bellona, Todaa, Bushnikc, Wrighta, Isaaca et al. (2017) evaluated the impact of a graduated physical activity programme on fatigue after TBI. Interventions included a home-based walking programme utilising a pedometer to track daily steps at increasing increments along with tapered coaching calls over a 12-week period. The intervention resulted in less fatigue for participants at the end of the active part of the intervention (24 weeks) and after a wash out period (36 weeks). This

study suggests that walking can be used as a cost-effective tool to improve fatigue in individuals with a TBI.

Medical interventions have been used to allevaite fatigue, including neurostimulants, dopaminergic medications and antidepressant medications, however there is very limited evidence for their effectiveness (Malley, 2017). Methylphenidate has been found to decrease mental fatigue and improve cognitive functions in individuals with a TBI (Johansson, Wentzel, Andrell, Ronnback & Mannheimer (2017) and Modafinil may help relieve excessive daytime sleepiness (Jha, Weintraub, Allshouse, Morey, Cusick, Kittelson, Harrison-Felix et al., 2008). If fatigue after ABI is associated with endocrine dysfunction, medication to address physiological factors associated with fatigue can be effective (Englander, Bushnik, Oggins & Katznelson, 2010; Zaben, El Ghoul & Belli, 2013).

Malley (2017) suggests that fatigue management must incorporate a holistic, person-centred, biopsychosocial approach. Some people may require a brief intervention whilst others may need group and/or individual interventions, thus requiring a personalised approach.

1.5.6. Rehabilitation of Awareness of Deficits

The management of impaired self-awareness is one of the most challenging issues to address in rehabilitation (Ownsworth, 2017). In a systematic review conducted by Schrijnemaekers, Smeets, Ponds, van Heugten, & Rasquin (2013), the authors reviewed nine interventions that aimed to improve the awareness of deficits in patients with ABI. The evidence for effective interventions was scarce, however the authors propose guidelines for a general approach to improve awareness. They suggest that for individuals who have the ability to understand that a specific function is impaired, an intervention should include a combination of training in

functional skills in multiple settings and multimodal feedback related to performance (Schrijnemaekers et al., 2013).

Metacognitive skills training can facilitate the development of self-awareness and has shown promise in improving the abilities of people with TBI to recognise and self-correct errors in everyday tasks (Fleming & Schmidt, 2015). Fleming & Ownsworth (2006) describe the components of rehabilitation that can improve self-awareness, including: establishing a good therapeutic alliance; assessment of feedback; psychoeducation; family interventions; group therapy; comprehensive day programmes; and psychotherapy. These approaches are aimed at improving functionality and psychological wellbeing but can also improve self-awareness (Ownsworth, 2017). Fleming & Ownsworth (2006) highlight that it is pointless or even harmful for an intervention to mainly focus on increasing awareness of post-injury impairments, unless there were gains in other relevant areas of skill and wellbeing.

Several studies have demonstrated that impairments in self-awareness can be effectively treated and substantial support has been found for the use of direct corrective feedback to improve self-awareness (Tate et al., 2014). Goveror, Johnston, Toglia, & DeLuca (2007) used an awareness training protocol embedded within the practice of instrumental activities of daily living (IADLs). Although the intervention significantly but selectively improved self-awareness during IADL task performance, the number of participants in this RCT was small and therefore this study should be replicated with a larger number of participants. An RCT conducted by Cheng & Man (2006) investigated the effectiveness of a newly developed Awareness Intervention Programme and their study supports the efficacy of multi-component feedback that involves training awareness and self-regulation skills on everyday tasks. The functional outcomes of the participants in the experimental group did not show significant differences and the authors suggest that the new programme could be further

developed to extend a better carryover treatment effect to functional improvement in daily activities (Cheng & Man, 2006).

A systematic review conducted by Schmidt, Lannin, Fleming, & Ownsworth (2011) examined the effectiveness of self-awareness interventions that involve a component of feedback for adults with brain injury. Feedback interventions produced modest improvements in self-awareness and the authors suggest that further research is required to determine the effects of integrating feedback interventions into rehabilitation programmes and the impact of this on functional outcome. An RCT conducted by Schmidt, Fleming, Ownsworth & Lannin (2013) found that an approach using video combined with verbal feedback was effective in improving self-awareness in people with TBI. It was interesting to note that improvement in self-awareness was not accompanied by an increase in distress levels.

Lamberts et al. (2016) evaluated a self-awareness treatment that was part of a treatment protocol on executive dysfunction. The intervention resulted in better self-awareness for the intervention group and results confirmed that the level of self-awareness before treatment was related to emotion recognition. The authors conclude that self-awareness can improve after neuropsychological treatment fostering self-monitoring (Lamberts et al., 2016).

FitzGerald (2010) describes a computer-based intervention programme that was developed to enhance emergent awareness in individuals with a brain injury. Participants were required to monitor performance during a sustained attention task administered in eight sessions over four weeks, with the intervention groups receiving feedback-on-error. Emergent awareness increased in the treatment groups from pre- to post intervention suggesting that repetitive practice may engender processes of error detection, evaluation or the deployment of controlled processes that underpin awareness deficits following ABI (Fitzgerald, 2010). This initial small-scale study warrants further investigation.

1.6 Assessing Effectiveness of Interventions

Scores on neuropsychological assessments are often used as outcome measures when examining the effectiveness of rehabilitation interventions, as is the case in this study. However, many neuropsychological tests have poor ecological validity and there is a large gap between neuropsychological tests and real life situations (Spikman, 2017). Difficulties on tests may not show in everyday life and difficulties in everyday life may not be captured by tests (Manchester, Priestly & Jackson, 2004). Executive functioning deficits are considered particularly difficult to capture in formal testing (Wall, Turner & Clarke, 2013). Wilson et al. (2009) argue that given that the ultimate aim of neuropsychological rehabilitation is to enable people to participate in valued activities, where possible, outcome should be measured at the level of everyday functioning.

Although randomised controlled trials (RCTs) are considered the best practice methodology for evaluating the effectiveness of therapeutic interventions (Hinton-Bayre & Kwapil, 2017), they are not easy to implement in rehabilitation and they need to be thought out carefully (Wilson et al., 2009). RCTs can also bring disadvantages such as complexity and expense (Hart 2017). Wilson et al. (2009) believe that RCTs are not the only way to evaluate rehabilitation and point out that there is increasing recognition that RCTs are of limited value in determining the efficacy of rehabilitation interventions.

An increasingly common control condition in rehabilitation trials is the wait-list control (Hart, 2017), which was used in this current study. However, patients in wait-list groups may do worse than those who neither receive nor anticipate treatment (Mohr, Spring, Freedland, Beckner, Arean, Hollon et al., 2009). One option to overcome this problem is to create a sham treatment that superficially resembles the condition thought to be active and includes non-specific but non-harmful ingredients (Hart, 2017). Participants in wait-list control groups can sometimes demonstrate improved performance on cognitive outcome

measures from pretest to posttest, despite not having received the treatment (Rohling et al., 2009). Factors that may account for this are changes in motivation from pretest to posttest, placebo effects due to additional individualised attention received by participation in a research study, practice effects on the tests themselves, and spontaneous recovery of cognitive function during the study period (Rohling et al., 2009), with these factors also applicable to intervention groups.

There are several dificulties inherent in real world clinical intervention studies. One issue is the recruitment of participants, as they may not see the value of participating in a study, particularly for those in a wait-list control group. Individuals with an ABI have many challenges in their daily lives and therefore may not want to engage in a research study which requires the completion of tests and questionnaires, as this may be seen as an extra burden for them. If the study requires travel to a centre, this may pose logistical challenges and act as a disincentive to participation. If individuals do sign up to a research project, they may not be in a position to complete it due to illness, personal and family issues, which can result in high attrition rates. These challenges can result in small sample sizes which lack adequate power for statistical analysis. One way to address this issue is to use multicentre sites (e.g. Zedlitz et al., 2012), in order to increase the sample size, which is the approach taken in this study.

Another difficulty researchers face is controlling for the multiple variables that can influence change on a particular outcome, including spontaneous recovery, other therapies, rehabilitation programmes or education the person is receiving and family support. This information can be captured but it is very challenging to control for these multiple variables. One way to address this issue is to use mixed method analyses, for example single case experimental design in addition to group studies and using both quantitative and qualitative methods (e.g. Allen, Doherty, Commins & Roche, 2019). Another difficulty is the heterogeneity of participants, although this can also be seen as a positive. Participants will

vary in relation to the type and severity of brain injury they have acquired and will also vary on demographic variables such as gender, age, occupation and employment status, living status, relationship status and education level. One way to address this is to include a large sample size, which allows generalisation of findings for particular ABI sub-groups as well as allowing an examination of the individual characteristics that optimise the clinical outcomes of rehabilitation. Participant heterogeneity can be exploited to investigate how different individual factors influence the success of an intervention (Radford et al., 2012).

1.7 Practice Effects

An important issue to consider with the use of neuropsychological assessments is that the repeated administration of the same neuropsychological tests raises the issue of practice effects, that is learning on a specific test (Sohlberg, McLaughlin, Pavese, Heidrich, & Posner, 2000). Healthy subjects in particular are susceptible to practice effects with repeated testing, but so are many individuals with brain injury (Lezak, 2012). An individual's performance on a test following repetition can vary according to the nature, site and severity of a brain lesion and with the individual's age (Lezak, 2012). No clear pattern has emerged from studies investigating the effect of age on practice effects (Lezak, 2012). Tests that have a large speed component, require an unfamiliar or infrequently practised mode of response, or have a single solution are particularly vulnerable to practice effects (Basso, Bornstein & Lang, 1999; McCaffrey, Ortega & Haase, 1993). Memory tests are particularly vulnerable to practice effects as individuals can learn the material, except for those who are seriously memory-impaired (Wilson et al., 2000).

The greatest practice effects are likely to occur between the first and second examinations on many tests (Benedict & Zgaljardic, 1998; Ivnik, Smith, Lucas, Petersen, Boeve, Kokmen et al., 1999). One solution to this is to use alternative test forms at different

timepoints, however, unavailability of appropriate alternative test forms is a common limitation for most tests used in neuropsychological assessments (Lezak, 2012). Another factor to consider is that if alternative forms do not have an equal level of difficulty, changing forms may introduce more unwanted variance than practice effects (Benedict & Zgaljardic, 1998). Even if alternative forms are used, there can be a general test-taking benefit whereby enhanced performance may occur after repeated examinations (Benedict & Zgaljardic, 1998; B.A. Wilson, Watson et al., 2000). This can be due to participants being less anxious the second or third time around because of familiarity with the examiner and procedures (Lezak, 2012). Practice effects can still occur with the use of alternative forms where individuals learn to use an effective test-taking strategy or have acquired "test-wiseness" (Beglinger, Gaydos, Tangphao-Daniels, Duff, Kareken, Crawford, Fastenau, et al., 2005). A recommended approach to overcome these diffculties is to include two or more baseline assessments before introducing the main assessments (McCaffrey & Westervelt, 1995).

1.8 Individual vs Group Approach to Rehabilitation

Many rehabilitation providers focus on one-to-one interventions with patients, however a group approach can also be effective. While there are benefits from individual attention and tailored interventions, group-based interventions have many practical and economic benefits, with the potential to make cognitive rehabilitation accessible to more patients (Radford et al., 2012). However, a systematic review conducted by Rees et al. (2007) found limited evidence for the short term effectiveness of group-based interventions for the treatment of executive dysfunction in individuals with moderate to severe TBI. This is an area that requires further investigation and the current study aims to add to this body of research.

Wilson et al. (2009) believe that the great benefit of a group format is that it provides the opportunity for clients to learn from their peers, through group discussion and other

means. Wilson (2009) found that patients often find it easier to accept advice or recommended strategies from peers rather than professional staff. Wilson (2009) observed group members support less able people and form friendships with others. This psychosocial element to group programmes can have significant benefits for group members, for example reducing anxiety and depression, increasing social support and instilling hope, all of which can impact on neuropsychological functioning. Evans & Wilson (1992) report that patients with an ABI taking part in a memory group, found that being with others who were experiencing similar difficulties was both helpful and enjoyable. However, a weakness of a group-based approach is the fact that it can involve a heterogeneous group with varying abilities, deficits and life goals and therefore can pose a challenge in meeting individual needs.

A randomised controlled trial conducted by Thickpenny-Davis & Barker-Collo (2007) showed improvement on memory tests as well as self-reports and significant other reports of improvement in real life, following a group memory rehabilitation programme. Improvements were maintained at a one month follow-up. O'Neil-Pirozzi, Strangman, Goldstein, Katz, Savage & Kelkar et al. (2010) used a group format to teach a more structured experimental intervention using multiple internal strategies (semantic association, elaboration, chaining, and imagery) along with "complementary" external strategies (memory book, PDA, etc.) across 12 structured sessions. Training methods combined errorless learning and metacognitive strategies. Gains were made across all levels of memory severity, with better outcomes found for mild to moderately memory-impaired patients and for those with better executive cognitive skills.

In a group-based study investigating cognitive strategy training by Huckans Pavawalla, Demadura, Kolessar, Seelye, Roost, et al. (2010), participants reported "significantly increased use of compensatory cognitive strategies and day planners, an

increased perception that these strategies were useful to them, increased life satisfaction and decreased depressive, memory and cognitive symptom severity" (p.43). They suggest that it is possible that greater use of compensatory strategies contributed to an increase in self-efficacy and hopefulness (Huckans et al., 2010). Rath et al. (2003) reported improvements following a group treatment of problem-solving deficits for individuals with a TBI, thought to be due to successful compensatory strategy use.

Jennett and Lincoln (1991) found that group instruction in the practical use of memory aids increased the number of memory aids used by patients compared with wait-list controls. A group programme run by Evans & Wilson (1992), integrating external and internal strategies while also focusing on fostering social support among memory-impaired patients, showed additional benefits in reducing symptoms of anxiety and depression.

A randomised controlled trial conducted by Schmitter-Edgecombe, Fahy, Whelan & Long (1995) provides preliminary evidence for the efficacy of group instruction in reducing "everyday memory failures" following a 9-week memory notebook treatment programme. The programme incorporated both behavioural learning principles and educational strategies for individualising instruction, with didactic lessons and homework assignments presented by the therapists. A recent study by Storzbach, Twamley, Roost, Golshan, Williams, O'Neil, et al. (2017), involving group-based compensatory cognitive training, found that their ten-week programme facilitated behavioural change (use of cognitive strategies) as well as both subjective and objective improvements in targeted cognitive domains. Another study by Lesniak (2018) found that cognitive rehabilitation conducted in either a group or individually led to equally enhanced memory functioning in individuals with an ABI, but the effects were not significantly different from those in the control (no treatment) group.

Evidence-based reviews suggest that the most efficacious approach to cognitive rehabilitation is comprehensive day-treatment programmes that include individual and group

sessions for several hours per day, several days per week (Cicerone et al., 2000, 2005). "These programmes include a series of bottom-up and top-down approaches to cognitive rehabilitation, and many also strive to address mood and adjustment issues" (Dams-O'Connor & Gordon, 2013, p.54).

1.9 Summary of the Evidence Base

Several seminal publications in recent years support the effectiveness of cognitive rehabilitation as well as broader holistic neuropsychological rehabilitation interventions for individuals following TBI and stroke (Cicerone et al., 2000; Cicerone et al., 2005; Cicerone et al., 2011; Cicerone et al., 2019; Gordon et al., 2006; Rohling et al., 2009; SIGN Guidelines, 2013). The Brain Injury Interdisciplinary Special Interest Group (BI-ISIG) of the American Congress of Rehabilitation Medicine (ACRM) conclude that holistic rehabilitation programs should be considered practice standard following moderate and severe TBI (Cicerone et al., 2011).

The efficacy of memory rehabilitation in the TBI population has been supported in several reviews (e.g., Cicereone et al. 2005; Cicerone et al., 2011; Cicerone et al., 2019; Elliott & Parente, 2014; Rees, et al., 2007). Memory strategy training in particular is recommended, with compensatory strategies found to have evidence of "probable effectiveness" for persons with moderate or severe memory impairment after TBI or stroke (Cicerone et al., 2011). INCOG recommendations for rehabilitation of memory impairments support the integration of internal and external compensatory strategies implemented using appropriate instructional techniques that consider functional relevance and important patient characteristics (Velikonja et al., 2014). The instructional strategies used as part of memory rehabilitation that are considered to be the most effective and commonly used include errorless learning, spaced retrieval and use of vanishing cues (Clare & Jones, 2008; Ehlhardt,

et al., 2008; Grandmaison & Simard, 2003; Haslam, et al., 2011; Piras et al., 2011). In relation to working memory training, current guidelines advocate the use of computer-based training programmes as an adjunct to evidence-based instructional and compensatory strategies (Nadar & McDowd, 2010; Velikonja et al., 2014).

Guidelines for attention training following TBI do not recommend reliance on repetition of computerised attention tasks due to limited evidence of generalisation to everyday attentional abilities (Bayley et al., 2007; Ponsford, Bayley et al., 2014). Some researchers have suggested that attention training may be helpful in conjunction with clinician-guided metacognitive training (Cicerone et al., 2011; Sohlberg et al., 2003; Fish, 2017). Metacognitive strategy training, environmental modification and use of assistive technology represent alternative or complementary treatments to computer-based attention training (Dymowski et al., 2016). In relation to stroke, cognitive rehabilitation for attention deficits may result in a short-term effect on attentional abilities.

There is substantial evidence to support strategy training for post-acute attention deficits post-TBI (Cicereone et al., 2005). INCOG recommendations for interventions to address deficits in attention include: (1) metacognitive strategy training applied to personally and functionally relevant tasks; (2) dual task training on individually relevant tasks; (3) Cognitive Behavioural Therapy (CBT) to address interactions between emotion and attention; (4) screening and treatment of sleep disorders that exacerbate attentional problems; (5) adapting the environment and tasks to minimise their attentional demands and maximise functioning; (6) methylphenidate effective as a short-term intervention for improving processing speed (Ponsford, Bayley et al., 2014). Mindfulness-based cognitive therapy has been shown to impact upon attention in other populations however, these studies have not incorporated active placebo conditions and therefore further research is required in this area, including research involving neurolgical populations (Fish, 2017).

Metacognitive approaches appear to have the best level of evidence in relation to improving executive functioning (Cicerone et al., 2011; Kennedy et al., 2008; Rohling et al., 2009), with some studies suggesting that interventions using Goal Management Training (GMT) combined with other training methods are more effective than GMT-alone interventions (Krasny-Pacini et al., 2014 Novakovic-Agopian et al., 2011; Miotto et al., 2009; Spikman et al., 2010). INCOG strongly recommend intervention programmes that incorporate metacognitive strategies for planning and problem-solving, focusing on everyday problems and functional outcomes (Tate et al., 2014). Strategy treatment may not be suitable for all individuals with brain injury, particularly those with severe injuries and limited self-awareness (Spikman, 2017).

Promising results have also been reported for interventions involving problem solving treatment (PST) with systematic reviews conducted by Cicerone and colleagues (Cicerone et al., 2000; 2005) concluding that there was sufficient research evidence to make interventions for problem solving a practice guideline when the intervention used functional activities and everyday situations. Promising results have also been reported for a treatment programme which combined GMT and PST with a general planning approach (Spikman et al., 2010).

There is growing evidence that cognitive behavioural therapy (CBT) interventions can improve psychological wellbeing following brain injury (Ownsworth & Gracey, 2017). There is insufficient evidence to recommend or contraindicate any treatments for fatigue post-TBI (Cantor et al., 2014 or post-stroke (Kutlubaev & Mead, 2012). In their systematic review, Cantor and colleagues (2014) recommend CBT as promising but requiring further study. A review conducted by Nadarajah & Goh (2015) concluded that approaches which incorporate both physical and psychological interventions may be beneficial for post-stroke fatigue. There is very limited evidence for the effectiveness of medical interventions to allevaite fatigue, including neurostimulants, dopaminergic medications and antidepressant medications

(Malley, 2017). Malley (2017) suggests that fatigue management must incorporate a holistic, person-centred, biopsychosocial approach.

Substantial support has been found for the use of direct corrective feedback to improve self-awareness (Tate et al., 2014). Schrijnemaekers et al., (2013) suggest that interventions should include a combination of training in functional skills in multiple settings and multimodal feedback related to performance.

1.10 ABI Ireland's Cognitive Group Programme

Acquired Brain Injury Ireland (ABI Ireland) is a not-for-profit organisation that provide community-based neurorehabilitation to individuals with an ABI in the Republic of Ireland. ABI Ireland run a 12-week Cognitive Group Programme which is the focus of the current research. The programme was already running for a period of time before the research was undertaken to investigate its effectiveness. The programme is focused on psychoeducation and introduces basic strategy training (internal and external) for cognitive deficits (attention, memory and executive functioning) as well as metacognitive approaches and education on environmental modifications in order to maximise cognitive functioning. The programme also educates participants on managing mood, stress fatigue and sleep, all of which can affect cognition, and encourages the implementation of strategies in participants' daily lives to reduce the negative impact of these factors.

The group approach used has many practical and economic benefits, allowing the organisation to reach a larger number of people with limited resources. The ABI Ireland programme uses a similar holistic approach as that used at the Oliver Zangwill Centre (OZC) for Neuropsychological Rehabilitation in Cambridgeshire, UK. The OZC opened in 1996 and was modelled on the American holistic programmes developed by Yehuda Ben-Yishay and George Prigatano. The OZC programme combines group and individual therapy to address

the cognitive, emotional and social problems faced by adults with acquired, non-progressive brain injury (Wilson et al., 2009).

Brain injury education is seen as an important element of the ABI Ireland programme, in line with previous research that found that brain injury education can have a positive effect on self-reports of psychosocial function (Sohlberg et al., 2000). The programme includes an emphasis on the development of metacognitive skills (self-awareness of post-injury impairments) which have been shown to impact on rehabilitation outcomes**,** community integration and vocational success (Fleming & Ownsworth, 2006; Ownsworth & McKenna, 2004).

Each week, participants complete homework exercises in order to consolidate their learning from each session and practice strategies. The last three weeks of the programme involve participants putting into practice what they have learnt from the programme through carrying out a group task and and planning a group activity. Further details on the programme can be found in Chapter 2.

1.11 Thesis Aims and Overview

This research aims to examine the effectiveness of an ABI Ireland Cognitive Group Programme in terms of cognitive and psychosocial variables, at its conclusion and six months later. It is hypothesised that taking part in the programme will result in significant change for participants in the cognitive variables of attention, memory and executive functioning, when compared to a control group and these changes will last beyond the programme.

The Cognitive Group Programme educates participants on stress, anxiety, sleep hygiene and fatigue management and introduces participants to stress management techniques which can be used in everyday life. Previous research has shown that brain injury education can have a positive effect on self-reports of psychosocial function (Sohlberg et al., 2000). It is therefore

hypothesised that taking part in the programme will result in significant change for participants in the psychosocial variables of distress and satisfaction with life, when compared to a control group and these changes will last beyond the programme. It is also hypothesised that taking part in the programme will result in significant change for participants in their knowledge of brain injury when compared to a control group and this change will last beyond the programme.

Given that community integration is considered to be one of the ultimate goals of rehabilitation after brain injury (Fortune & Richards, 2017), the primary outcome measure in this study is community integration, as measured by the Community Integration Questionnaire (CIQ). The programme is designed to maximise the transfer of learning from the group sessions to individuals' daily lives and to ultimately enhance community integration. It is therefore hypothesised that taking part in the programme will result in significant change for participants in community integration, when compared to a control group and this change will last beyond the programme.

Demographic variables such as age, time since injury and years of education have been shown to be correlated with outcome post brain injury (Green et al., 2008, Malec et al., 1991, Ponsford et al., 2008) and therefore it is hypothesised that these variables will be significantly correlated with results on neuropsychological tests and questionnaires. Given that cognition and emotion are interlinked (Wilson, 2011), it is hypothesised that levels of distress will be correlated with results on neuropsychological tests.

In summary, the main hypotheses of this study are as follows:

Hypothesis 1: Participation in the Cognitive Group programme will result in significant change for participants in the cognitive variables of attention, memory and executive functioning, when compared to a control group and these changes will last beyond the programme.

Hypothesis 2: Participation in the Cognitive Group programme will result in significant change for participants in the psychosocial variables of distress and satisfaction with life, when compared to a control group and these changes will last beyond the programme.

Hypothesis 3: Participation in the Cognitive Group programme will result in significant change for participants in their knowledge of brain injury when compared to a control group and this change will last beyond the programme.

Hypothesis 4: Participation in the Cognitive Group programme will result in significant change for participants in the primary outcome measure of community integration, when compared to a control group and this change will last beyond the programme.

Hypothesis 5: Demographic variables of age, time since injury and years of education will be significantly correlated with results on neuropsychological tests and questionnaires. Levels of distress will be correlated with results on neuropsychological tests.

Although research supports cognitive rehabilitation and holistic neuropsychological interventions after brain injury (Cicerone et al., 2000; Cicerone et al., 2005; Cicerone et al., 2011; Cicerone et al., 2019; Gordon et al., 2006; Rohling et al., 2009), the need for more research has been highlighted (das Nair et al., 2015), and in particular the need for more studies in real world contexts (Yeates, Levin & Ponsford, 2017). This research aims to address these gaps.

Group-based interventions have become more prevalent in healthcare environments over the last number of decades, given their practical and economic benefits (Patterson, Fleming & Doig, 2016), however, there is currently a lack of research investigating the effects of such interventions for individuals with ABI. One of the objectives of this current study is to add to the limited research available in this area and provide supporting evidence for the effectiveness of the current ABI Ireland programme. If the programme is found to be effective for individuals with an ABI, this will provide support for the continuation of the current programme. It will also

support the extension of the programme nationwide and to other brain injury service providers in Ireland and internationally.

Chapter 2

Cognitive Group Intervention

Overview

The purpose of this chapter is to provide details of the Cogntive Group programme which is the subject of this thesis. Details of the Cognitive Group intervention is outlined in Section 2.1, including the background to the programme development, the purpose and objectives of the programme and how it is administered in ABI Ireland. The programme is detailed in table 2.1, including each week's content, goals, underlying theory and homework assignments.

2.1 Intervention

The subject of this thesis is a programme, called the 'Cognitive Group', run by ABI Ireland for individuals with an Acquired Brain Injury (ABI). The programme has been running for a number of years in Dublin and Sligo regions and on average 2 programmes are run in Dublin and 1-2 in Sligo per year. The programme consists of a holistic approach that addresses multiple cognitive deficits as well as psychosocial issues that individuals typically face post brain injury, with underpinning theory that of holistic neuropsychological rehabilitation. The programme focuses on psychoeducation, basic strategy training for cognitive deficits and stress management techniques and as part of its holistic approach, there is a focus on individual's cognitive and emotional strengths.

Criteria for attending the programme is that a participant must be medically stable and presents with cognitive difficulties but has the ability to participate actively in the group programme. Participants need to have a functional level of language (expression and comprehension) and have the capacity to develop awareness of strengths and weaknesses as part of the programme. These criteria are assessed by clinical interview and outcome of initial assessment.

The programme was originally designed by a Senior Clinical Neuropsychologist in ABI Ireland in 2012 and is based on elememts of the holistic neuropsychological

rehabilitation programmes run at the Oliver Zangwill Centre (OZC) for Neuropsychological Rehabilitation in Cambridgeshire, UK. The purpose of the programme being established was to:

(1) provide clients with a greater understanding of the cognitive, interpersonal and emotional impact of brain injury

(2) help clients increase awareness of the impact of their injury on their functioning and to help them to cope with the grief that can develop as a result of injury

(3) help clients develop alternative/compensatory strategies to manage difficulties and to increase awareness of the importance of environmental restructuring.

Brain injury education is seen as an important element of the programme, in line with previous research that has shown that brain injury education can have a positive effect on self-reports of psychosocial function (Sohlberg et al., 2000). The programme provides education on the use of compensatory strategies (internal and external), with a focus on developing strategies that can be generalised to participants' everyday lives. The programme also includes an emphasis on the development of metacognitive skills (self-awareness of post-injury impairments) which have been shown to impact on rehabilitation outcomes, community integration and vocational success (Fleming & Ownsworth, 2006; Ownsworth & McKenna, 2004).

The programme consists of 2.5 hours (incorporating a 15 minute refreshment break) in a group setting one day a week for 12 weeks. On average there are 8-10 participants in each group. In Dublin, the programme is facilitated by a member of ABI Ireland staff (Neurorehabilitation Assistant) and overseen by a Senior Clinical Neuropsychologist and in Sligo the programme is facilitated by a Senior Clinical Neuropsychologist and an Occupational Therapist, with involvement from Assistant Psychologists. Facilitators use interactive presentations, group discussion and activities during the proramme. Programme

materials (powerpoint presentations and handouts) are standardised and available to facilitators on a central server location. New facilitators must sit in on a programme before delivering it themselves, to ensure programme fidelity.

Participants are given handouts each week on the topic being covered and must complete homework each week which is discussed in a group the following week. Inclusion of homework encourages participants to apply learning and generalise strategy use to everyday situations. The final weeks of the programme involve participants applying strategies learnt to real-life situations, including planning an outing as a group. The content of the programme is detailed in table 2.1 below.

Table 2.1: *Content of Cognitive Group Programme*

Week No.	Goal	Topic	Homework	Theory
1 (2.5 hrs)	To increase knowledge and understanding of the brain and ABI, including the unique nature of brain injury for each individual. To encourage personal reflection and increased awareness and to link challenges a person may be experiencing with different parts of their brain. Questionnaires are completed so that 'baseline' results can be obtained and participants can compare these with results at the end of the programme, using the same questionnaires.	Types of ABI; Interesting facts about ABI; The structure of the brain and how it gets damaged; Recovery after a brain injury. Completion of questionnaires.	Think of a difficulty you experienced during the week and try to identify what part of the brain may be responsible for this difficulty.	Importance of brain injury education which can have a positive effect on psychosocial functioning. Education on how the brain works aids understanding for later topics e.g. memory, attention etc. Homework provided to support consolidation of learning from the session and enhance self-awareness.

Week No.	Goal	Topic	Homework	Theory
2 (2.5 hrs)	To increase knowledge and understanding of the different lobes of the brain and how damage to different lobes can impact a person's life. To increase awareness of the various elements (brain function, physical states, psychological states and environment) involved in day-to-day functioning and how these are impacted by a brain injury. To encourage participants to make changes in their lives in order to reduce the negative effects of their brain injury. To increase awareness of how mood and fatigue can affect cognition and to encourage participants to reflect on how they can manage mood and fatigue, and get a good night's sleep.	Lobes of the brain and their function; 'Diamond of Day-To-Day Functioning' (covers brain function, physical states, mood/psychological states and environment); what 'cognitive' means and what can effect cognition negatively, for example mood and fatigue; Information on how to get a good night's sleep and how to manage fatigue.	Choose a problem during the week, identify the area of the brain involved and fill in the 'make a change' diagram. This diagram prompts participants to make changes in their lives in order to reduce the negative effects of their brain injury (e.g. if a person experiences severe fatigue they may decide to only call family and friends on the phone when they are at their best during the day and communicate this to family and friends).	Importance of brain injury education which can have a positive effect on psychosocial functioning. Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage behaviour change.

Week No.	Goal	Topic	Homework	Theory
3 (2.5 hrs)	To increase knowledge and understanding of the negative impact of stress and fatigue on brain functioning and the concept of 'vicious cycles'. To increase knowledge and understanding of fatigue management (including the importance of daily rests) the reason for fatigue and the factors that influence fatigue for each individual. To increase knowledge and understanding of how the brain processes information and how this can be slowed down after a brain injury. To encourage personal reflection and changes in behaviour in order to reduce the impact of stress and fatigue on daily functioning.	Cognitive functioning – what factors make it harder for the brain to function; 'vicious cycles' and how they work; Fatigue management.	Complete fatigue management record sheets.	Importance of a holistic approach to neuropsychological rehabilitation which includes addressing mood and fatigue as part of the rehabilitation process. Importance of brain injury education which can have a positive effect on psychosocial functioning. Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage possible behaviour change.

Week No.	Goal	Topic	Homework	Theory
4 (2.5 hrs)	To increase knowledge and understanding of what stress and anxiety are and how to manage these states, including the use of different relaxation exercises. To raise awareness amongst participants of their own stress and anxiety levels in order to encourage them to effectively manage these states.	Stress and anxiety – what it is and how to manage it; Relaxation: benefits, activities (re-breathing technique and a grounding relaxation exercise).	Participants to complete mood monitor handouts and relaxation record sheets (over the next two weeks).	Importance of a holistic approach to neuropsychological rehabilitation which includes addressing stress and anxiety as part of the rehabilitation process. Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage possible behaviour change.

Week No.	Goal	Topic	Homework	Theory
5 (2.5 hrs)	To increase knowledge and understanding of attention. To raise awareness amongst participants of challenges they may have with attentional deficits, how they can effectively manage them and how these challenges make them feel. To raise awareness amongst participants of various strategies they can use to manage attentional deficits.	Four types of attention; Sustained Attention (including sustained attention exercise) – common problems linked to sustained attention and strategies to manage it; selective attention (including selective attention exercise); common problems linked to selective attention and strategies to manage it.	'Where's Wally?' exercise. Participants are asked to take a note of their reaction to the task, any difficulties they encountered and their thoughts on the task.	Importance of brain injury education which can have a positive effect on psychosocial functioning. Use of strategies such as adapting the environment and tasks to minimise their attentional demands and maximise functioning and use of assistive technology is recommended (INCOG recommendations). Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage possible behaviour change.

Week No.	Goal	Topic	Homework	Theory
6 (2.5 hrs)	To increase knowledge and understanding of attention. To raise awareness amongst participants of challenges they may have with attentional deficits, how they can effectively manage them and how these challenges make them feel. To raise awareness amongst participants of various strategies they can use to manage attentional deficits.	Attention switching (including attention switching exercise), including common problems and strategies to manage it; Divided attention (including divided attention exercise), including common problems and strategies to manage it.	Participants complete a log of attention difficulties they encounter over the next week, with a friend or family member helping out.	Importance of brain injury education which can have a positive effect on psychosocial functioning. Use of strategies such as adapting the environment and tasks to minimise their attentional demands and maximise functioning is recommended (INCOG recommendations). Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage possible behaviour change.

Week No.	Goal	Topic	Homework	Theory
7 (2.5 hrs)	To increase knowledge and understanding of memory and how attention is related to memory. To raise awareness amongst participants of challenges they may have with memory deficits.	What memory is and why attention affects memory; Different types of memory; Memory difficulties that may occur after a brain injury; What is speed of information processing; Exercise – participants are asked to note down particular situations where they notice memory difficulties.	Participants perform three tasks which require different types of memory strategies to be used.	Importance of brain injury education which can have a positive effect on psychosocial functioning. Homework provided to support consolidation of learning from the session and enhance self-awareness.

Week No.	Goal	Topic	Homework	Theory
8 (2.5 hrs)	To increase knowledge and understanding of memory and how brain injury can result in memory difficulties. To raise awareness amongst participants of compensatory strategies (internal and external) they can use to manage memory difficulties. To make participants familiar with use of a daily diary and encourage use of a diary after completion of the programme.	The process of remembering and where the process can go wrong; Strategies to help with memory problems (including internal and external aids) and discussion of 'vicious cycles'; Exercise on memory problems, including discussion on strategies that can be used to help with these problems.	Participants complete a daily diary over the following week.	Importance of brain injury education which can have a positive effect on psychosocial functioning. Use of compensatory strategies (internal and external) to manage memory difficulties is recommended (INCOG recommendations). Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage use of a diary as an external aid to compensate for memory difficulties.

Week No.	Goal	Topic	Homework	Theory
9 (2.5 hrs)	To increase knowledge and understanding of executive functioning, including what it is, problems in this domain that can arise as a result of brain injury and strategies that can be used to manage these problems. To introduce participants to the concept of task analysis which can be used when managing executive functioning deficits.	What executive functioning is and what executive functioning problems can arise after brain injury; strategies that may help with these problems; Two exercises involving the use of executive functioning; Signs that indicate we are struggling to organise our lives effectively.	Participants carry out a task analysis exercise i.e. breaking an everyday task (e.g. cooking) into its component parts.	Importance of brain injury education which can have a positive effect on psychosocial functioning. Use of strategies to manage executive functioning difficulties, including metacognitive approaches which are recommended (INCOG recommendations). Homework provided to support consolidation of learning from the session, enhance self-awareness and encourage use of task analysis when tackling executive functioning difficulties.

Week No.	Goal	Topic	Homework	Theory
10 (2.5 hrs)	Participants to practice using executive functioning skills and to reflect on their performance after the task in order to build self-awareness.	Group task – telephone directory task which requires executive skills to be used. After the task a group discussion takes place regarding how the task was approached and whether the participants would do anything differently the next time. Completion of questionnaires and compare with week 1.	None	Practice using executive functioning skills in real-world situations assists participants in building confidence and self-awareness. Working as part of a group encourages peer support and peer learning.

Week No.	Goal	Topic	Homework	Theory
11 (2.5 hrs) & 12 (varies)	Participants to practice using executive functioning skills in a real-world situation involving a social activity. Participants to reflect on their performance after the task in order to build self-awareness. Note - The duration for week 12 varies depending on the activity planned but is on average 3-4 hours, including travel time.	Participants plan a group activity, for example going for a meal, going to the cinema, cooking a meal for a group etc. The group must work together to discuss various ideas, agree an activity and implement a plan of action, delegating responsibilities to different group members. On week 12 the group activity is completed and the group feed back to the facilitator after the activity.	None	Practice using executive functioning skills in real-world situations assists participants in building confidence and self-awareness. Working as part of a group encourages peer support and peer learning.

2.1.1. Programme Outline

Week 1: At the start of the programme, the facilitator introduces themselves, provides an outline of the Cognitive Group Programme and explains housekeeping issues such as break times, the location of toilets and how to contact the facilitator if they are unable to attend a particular week. Each participant is provided with a folder to store handouts provided each week and each member of the group introduces themselves. Participants are then asked to complete the following questionnaires: (1) Knowledge of Brain Injury; (2) Cognitive Group Self Evaluation; (3) Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen & Griffin, 1985); and (4) Community Integration Questionnaire (CIQ; Willer, Rosenthal, Kreutzer, Gordon & Rempel, 1993), with assistance provided by the facilitator as necessary. The facilitator explains that the same four questionnaires will be completed in week 10 of the programme and results compared between week 1 and week 10. Questionnaires are completed at week 10 as week 11 is dedicated to the planning of an outing and the planned activity takes place in week 12, resulting in less time being available for completion of questionnaires.

The first topic covered is the types of ABI snd the facilitator explains the various types of ABI with the group, including traumatic and non-traumatic causes. This provides an opportunity for participants to appreciate the many types of ABI. The facilitator then discusses some interesting facts about ABI such as incidence rates in Ireland and a breakdown of causes of TBI by percentage in Ireland. The structure of the brain is then discussed, including the structure of a neuron. Participants then draw a diagram of a neuron and label the parts. The facilitator then explains how brain cells can become damaged. Finally, recovery after a brain injury is discussed, emphasising that recovery is usually slow and each person's recovery is unique to that individual. The facilitator highlights that 'trying

harder' to speed up recovery can sometimes make things worse and also explains that some people can lack awareness of their difficulties because of the brain injury.

Homework for week 1 consists of participants thinking about a difficulty they experienced during the week and trying to identify what part of the brain may be responsible for this difficulty. The idea behind this exercise is to deepen participants' knowledge of the different parts of the brain and their function.

Week 2: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. The first topic covered on week 2 is the lobes of the brain and their function. Participants receive information regarding typical problems people may experience when particular areas of the brain are damaged and participants can relate this information to their own experience. Symptom phrases such as 'forgetting my keys' or 'changes in my personality' are related to the relevant parts of the brain.

The facilitator then introduces the 'Diamond of Day-To-Day Functioning' by drawing it on a flipchart. The diamond has four categories; brain function (e.g. cognitive, emotional, behavioural, physical and sensory), physical states (e.g. pain, fatigue, hunger and effect of alcohol/drugs), mood/psychological states (e.g. anxiety, depression, frustration and anger) and environment (e.g. noisy, busy and disorganised). Participants are asked to give examples under each of the four categories and these are written onto a flipchart and discussed. The facilitator explains that people can do some things and not others and that people can do things at some times and not others. This builds participants' awareness of the various elements involved in day-to-day functioning and how they can be impacted by a brain injury. It also prompts participants to think about how they can work with different parts of the diamond to improve day-to-day funtioning.

The facilitator then explains the definition of 'cognitive' and what can affect cognition negatively, for example mood and fatigue. Information is provided on how to get a good night's sleep and how to manage fatigue, as these impact on cognition. Participants are asked to write down when their cognitive functions are at their worst, in order to develop awareness of individual difficulties and how they can effectively manage them.

For homework, participants must choose a problem they are having during the week, identify the area of the brain involved and fill in a 'make a change' diagram. This diagram prompts participants to make changes in their lives in order to reduce the negative effects of their brain injury. It covers information needed, what a person wants to achieve, obstacles, fears, a person's strengths and support structures.

Week 3: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. The first topic covered on week 3 is cognitive functioning and what factors make it harder for the brain to function, with reference to the diamond of day-to-day functioning covered the previous week. The facilitator then introduces the concept of 'vicious cycles'. They explain that a brain injury can cause frustration, anger and fatigue, resulting in the brain working less effectively which in turn can cause symptoms to be exaggerated and cause more frustration, anger and fatigue. This raises participants' awareness of the importance of breaking 'vicious cycles' by being aware of them and using strategies to cope with difficulties.

The facilitator then discusses speed of processing after ABI and uses a diagram to explain how the brain processes information and how this can be slowed down after a brain injury. This explains to participants how processing information takes longer after a brain injury and the brain has to work harder than before, thus cognitive fatigue is common.

The next topic covered is fatigue management and a handout is provided with tips on how to reduce the impact of fatigue and how to get a good night's sleep. Participants are

encouraged to think about when their energy levels are best during the day and to match tasks according to this, for example tackling the most demanding tasks when they have the highest energy levels. Homework is to complete fatigue management record sheets.

Week 4: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. The topic covered on week 4 is stress and anxiety, including an explanation of what it is, negative effects of stress and anxiety and how to manage it. Information is given on the benefits of relaxation, establishing a relaxation routine and dealing with frustration. The facilitator introduces a technique called re-breathing which can be used when a person becomes stressed, in order to induce calmness. The facilitator talks the group through the technique and asks participants to try the technique at home during the week. The facilitator also introduces a grounding relaxation exercise which is a quick and easy way to bring attention back to the present and to stop thinking about something that is upsetting. It can also be used to relax at any time in practically any situation. Participants are given a small card with prompts for the exercise on it which they can carry with them in a pocket or wallet. For homework, participants are asked to complete mood monitor handouts and relaxation record sheets (over the following two weeks).

Week 5: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. The first topic covered on week 5 is attention. The facilitator explains the different types of attention, including sustained attention, selective attention, attention switching and divided attention. Participants take part in two exercises, one involving sustained attention and the other selective attention. After each exercise, participants are asked to write down their reaction to the task and note how difficult they found the task. This is then followed by a group discussion whereby participants increase their awareness of attention deficits they may have

and how it makes them feel. The group carries out a brainstorming exercise whereby they discuss strategies that can be used to manage attention deficits. They are also given a handout with recommended strategies for managing attention. The facilitator discusses common problems that people might experience as a result of attention deficits, allowing participants to develop a better understanding of why they are having difficulties in relation to certain aspects of daily functioning. Homework involves a 'Where's Wally?' exercise. Participants are asked to take a note of their reaction to the task, any difficulties they encountered and their thoughts on the task.

Week 6: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. The facilitator continues on from the discussion of attention the previous week, covering attention switching and divided attention. Participants take part in two exercises, one involving attention switching and the other involving divided attention. The attention switching exercise involves a sheet being passed around, containing boxes with the words 'fruit' 'vegetable' or 'animal'. Each person has to write the name of a fruit, vegetable or animal in the corresponding box and then pass it to their neighbour. The divided attention exercise involves completing a form while a news report is playing in the background. Participants are asked to pay equal attention to the form and the news report and are asked questions about both when they have completed the form. After each exercise, participants are asked to write down their reaction to the task and note how difficult they found the task. This is then followed by a group discussion whereby participants increase their awareness of attention deficits they may have and how it makes them feel. The group carries out a brainstorming exercise whereby they discuss strategies that can be used to manage attention deficits. They are also given a handout with recommended strategies for managing attention. For homework, participants are asked

to complete a log of attention difficulties they encounter over the next week, with a friend or family member helping out.

Week 7: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. The topic covered on week 7 is memory. The facilitator starts the session with an explanation of what memory is, the different types of memory and why attention affects memory. The group discusses memory difficulties that occur after a brain injury and participants are asked to note down particular situations where they notice memory difficulties. Homework consists of participants performing three tasks (e.g. ring the office on a particular date at a particular time), all of which rely on the use of different types of memory stratetgies.

Week 8: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. Week 8 continues on the topic of memory. The facilitator starts the session with an explanation of the process of remembering and where the process can go wrong. Then there is a discussion around strategies to help with memory problems (including internal and external aids) and a reminder of 'vicious cycles' that was covered in week 3. Participants complete an exercise which involves noting down memory problems they have experienced over the last two weeks, noting what memory strategies they used and how they might improve these strategies or what new strategies they might use. This is followed by a group discussion on strategies that can be used to help with these problems. For homework, participants complete a daily diary over the following week and a template is provided. This homework exercise is designed to encourage use of a daily diary as an external memory aid, with the hope that participants will see the benefits of such a strategy and continue to use it after programme completion.

Week 9: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. Week 9 introduces the topic of executive functioning. The facilitator provides an explanation of what executive functioning is, what problems can arise after a brain injury and what can be done to manage deficits in executive functioning. Two group exercises are carried out which require use of executive functioning skills. The first of these is one of the exercises from the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie & Evans, 1996) and involves getting a cork out of a beaker of water. The second exercise involves brainstorming the qualities to look for in a good manager (as these relate to executive functioning abilities). This provides an opportunity for the group to discuss how executive functioning is used in day-to-day life and the challenges people may experience as a result of deficits in executive functioning. The facilitator discusses the signs that indicate a person might be struggling to organise their lives effectively and also discusses strategies that may help with these problems. For homework, participants are asked to pick a task they would normally do and carry out a task analysis exercise i.e. breaking the task (e.g. cooking) down into its component parts. This assists participants in planning and organising tasks and demonstrates the benefit of task analysis for everyday activities.

Week 10: The facilitator starts the session with a re-cap of what was covered the previous week and a group discussion regarding the homework exercise. Week 10 involves a group task which requires executive skills to be used. Participants must imagine that they have moved into a new house in an unfamiliar area and must complete certain tasks such as getting a new sink in the bathroom, repairing the damaged fuse box etc. Participants are given a golden pages phone directory and must compile a list of people/companies they have to contact, organising the information on a sheet of paper. The group is given 15 minutes to complete the task. On completion of the task, a group discussion takes place regarding how

the task was approached and whether the participants would do anything differently the next time. The last part of the session involves participants completing the same questionnaires that were completed on week 1, allowing them to compare their results. Questionnaires are completed at week 10 as there is more time available at this session for the completion of questionnaires. No homework is given on week 10.

Week 11 & 12: The facilitator starts the session with a re-cap of what was covered the previous week. Participants are then asked to plan a group activity, for example going for a meal, going to the cinema, cooking a meal etc. which will take place the follwoing week. The group must work together to discuss various ideas, agree an activity and implement a plan of action, delegating responsibilities to different group members. This activity allows participants to demonstrate a variety of skills and strategies that they have learnt over the previous 10 weeks of the programme. On week 12 the group activity is completed and the group feeds back to the facilitator after the activity.

Chapter 3

General Methods

Overview

The purpose of this chapter is to provide details of the study design, participants and their recruitment, the test battery used and finally, details of statistical analysis used in this study. The study desgn is detailed in Section 3.1. Section 3.2 provides details of demographic information that was collected from research participants, followed by Section 3.3 which details the test battery that was used in the study. The process followed to obtain ethical approval for the study is detailed in Section 3.4 and details of how participants were recruited to the study are outline in Section 3.5. Information regarding participants is provided in Section 3.6 and finally section 3.7 details the statistical analysis conducted for this study.

3.1 Design

This study uses a matched control design. Individuals with an ABI, meeting inclusion criteria, who signed up for participation in a Cognitive Group Programme run by ABI Ireland, were invited to participate in the research. This group was then matched with a control group on gender, age (to within one standard deviation) and type of ABI. The control group consisted of people who were on a waiting list for a Cognitive Group Programme and potential candidates were provided with an advert and information sheet regarding the study by their local Clinical Neuropsychologist. If a person was interested in taking part in the study, the Clinical Neuropsychologist passed on their name and contact details to the researcher. The inclusion of a control group allowed the author to investigate whether participating in the programme brings about significant change in cognition, distress, satisfaction with life, community integration and knowledge of brain injury, relative to those who have not participated.

Participants completed a series of neuropsychological tests and questionnaires (see section 2.4 for details of test battery) which measured cognition (attention, memory and

executive functioning), distress, satisfaction with life, community integration and knowledge of brain injury. Community integration was designated as the primary outcome measure for this study, given that community integration is considered to be one of the ultimate goals of rehabilitation after brain injury (Fortune & Richards, 2017). Tests and questionnaires were completed on induction to the programme, on completion of the programme, and at 6 months follow up to assess longevity of any effect of the intervention. The same timepoints were used for the control group.

Tests and questionnaires were conducted by the author in the participants' home/place of residence. For the intervention group, questionnaires for timepoint 1 and 2 were completed as part of the Cognitive Group Programme, as per normal practice.

3.2 Demographic Information

Demographic information was collected on gender, age, time since injury, severity of brain injury, type of ABI, employment status, relationship status, living status, occupation prior to injury, education level, current brain injury service accessed, alcohol use, previous mental health history and ethnicity. Brain injury severity was rated using a combination of the Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974), post-traumatic amnesia (PTA) and the duration of loss of consciousness (LOC; Russell & Smith, 1961), with TBI categorised as mild, moderate or severe (see tables 3.1 and 3.2 below). The Glasgow Coma Score includes a fifteen-point scale which is applied to the patient's level of consciousness; scores of less than eight are considered severe, 9–12 as moderate, and 13–15 as mild. For non-traumatic brain injuries where there was no loss of consciousness, severity of injury was rated according to the person's functional outcome and corroborated by a Senior Clinical Neuropsychologist in ABI Ireland who had access to the person's medical history.

Table 3.1: *TBI Severity (Russell & Smith, 1961)*

Severity	PTA (Post Traumatic Amnesia)	LOC (Loss of Consciousness)
Very mild	Less than 5 minutes	
Mild	5 minutes to 60 minutes	Less than 30 minutes
Moderate	1 hour to 24 hours	30 minutes to 24 hours
Severe	1 day to 7 days	More than 24 hours
Very Severe	1 to 4 weeks	
Extremely Severe	More than 4 weeks	

Table 3.2: *Glasgow Coma Scale (Teasdale & Jennett, 1974)*

Eye Opening	Verbal Response	Motor Response
4 Spontaneous	5 Oriented to person, place, month & year	6 Obeys commands
1 Eye opening to verbal command	4 Confused	5 Localises pain
2 Eye opening to pain	3 Inappropriate words	2 Withdraws to pain
1 No eye opening	2 Sounds but words not understandable	3 Abnormal flexion to pain
	1 No verbal response	2 Abnormal extension to pain
		1 No motor response

3.3 Test Battery

In choosing the neuropsychological tests for the test battery, a review was carried out on similar intervention studies which assessed cognition in a brain injury population. The most common tests used in these studies were considered for this study, and factors such as the reliability and validity of the test, the time required to administer the test and suitability for a brain injury population were taken into account. In relation to use of the the California Verbal Learning Test-Second Edition (CVLT-II) as a test for verbal learning and memory, the fact that this test assesses semantic clustering (the ability to employ executive or organising strategies to enhance learning; Lajiness et al., 2013) was a factor in the decision to include this test. In relation to the questionnaires used in the study, the questionnaires (except the Hospital Anxiety and Depression Scale) were already in use as part of the Cognitive Group programme. The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was included in order to assess any change in distress levels amongst participants.

3.3.1. California Verbal Learning Test-Second Edition (CVLT-II)

The California Verbal Learning Test-Second Edition (CVLT-II; Delis, Kramer, Kaplan & Ober, 2000) was used to assess participants' episodic verbal learning and memory (see Appendix A). This test is commonly used during a neuropsychological assessment to assess an individual's learning and memory skills and its use with various neurological conditions has been supported through studies of criterion validity (DeJong and Donders, 2010).

The CVLT-II measures both recall and recognition of two lists of words over a number of immediate- and delayed-memory trials. In the first five trials, the examinee is asked to recall words from a list (List A) immediately after hearing the list being read aloud. Lists comprise of 16 words, with four words from four semantic categories. Words from the same semantic category are not presented consecutively, which allows for an assessment of

the person's ability to employ executive or organising strategies to enhance learning (Lajiness-O'Neill et al., 2013). Semantic clustering is considered to be the most effective strategy for learning unstructured verbal information. An interference list (List B) of 16 words is then presented to the participant. This examines the effects of proactive interference, which refers the degree to which prior learning interferes with new learning. This is then followed by short-delay free-recall and short-delay cued-recall trials of the original list (List A). There is then a 20-minute delay, during which nonverbal testing takes place. This is followed by the administration of long-delay free-recall, long-delay cued-recall and yes/no recognition trials of List A. The final part of the CVLT-II consists of a forced-choice recognition trial, administered approximately 10 minutes after the delayed recognition trial, which specifically probes for the benefits of cueing on retrieval. "Because forced-choice with completely unrelated items is easier than yes/no recognition, this measure was added to detect motivation lapses" (Lezak, Howieson, Bigler & Tranel, 2012, p.478).

The CVLT-II captures the number of repetitions and intrusions a person makes when recalling words. Individuals who repeat an abnormal number of words (i.e. 9 or more) have attentional problems as demonstrated by difficulty keeping track of what they have already said while searching their memory for other words (Lezak, 2012).

The CVLT-II has been used in other intervention studies with a brain injury population. Twamley et al. (2014) used the CVLT-II to measure verbal learning and memory in their study investigating the effectiveness of a 12-week intervention called CogSMART for individuals with TBI. The CVLT-II was also used by Richter, Modden, Hanken & Hildebrandt (2015) to assess verbal memory in a study investigating whether recovery in various cognitive functions is supported by one or two more fundamental functions in a brain injury population.

The construct validity of the CVLT-II as a measure of episodic verbal learning and memory is supported by a considerable body of research (Woods, Delis, Scott, Kramer & Holdnack, 2006). Comparing retest reliabilities at one month, adults receiving the standard form on both occasions had reliability coefficients on the primary measures ranging from .80 to .89 (Woods et al., 2006). The CVLT (Delis, Kramer, Kaplan & Ober, 1987) has been shown to be vulnerable to significant practice effects in a psychiatric population (Hawkins & Wexler, 1999) and a HIV-infected population (Duff, Westervelt, McCaffrey & Haase, 2001) and therefore caution must be exercised in interpretation of test results.

Working memory tasks that call for temporary storage and manipulation of information are thought to involve the frontal lobes (Braver et al., 1997). Baldo, Delis, Kramer & Shimamura, (2002) found that patients with circumscribed frontal lobe lesions completing the CVLT-II have a depressed learning curve, an increased tendency to make intrusions, reduced semantic clustering and impaired yes/no recognition performance. They also found that pateints benefited slightly from cueing and recalled slightly more words in Long-Delay Free Recall than in Short-Delay Free Recall (Baldo et al., 2002).

The temporal lobes are also important as one of their primary functions is memory, with left temporal lobe lesions tending to disrupt verbal memory (Lezak et al., 2012). Performance on memory tests relies on the ability to pay attention during the task and therefore poor performance on the CVLT-II can be a result of poor attention as opposed to poor memory functioning. The prefrontal cortex is one of the important structures involved in attention and when attentional deficits occur, overall cognitive productivity suffers (Lezak etal., 2012). In addition, patients with prefrontal damage may be sluggish in reacting to stimuli, unable to maintain an attentional focus, or highly susceptible to distractions (Stuss, 1993), thus affecting their performance on meory tests such as the CVLT-II.

3.3.2. Trail Making Test (TMT)

The Trail Making Test from the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan & Kramer, 2001) was used to assess participants' executive functioning skills (see Appendix B). This test is a modification of the classic test originally developed by Partington (Brown & Partington, 1942; Partington & Leiter, 1949) and by U.S. Army psychologists for use in the *Army Individual Test Battery* (1944), and later popularised as a neuropsychological test in the *Halstead-Reitan Neuropsychological Battery* (HRNB; Reitan & Wolfson, 1993).

The procedures and tasks used in D-KEFS have demonstrated sensitivity in the detection of frontal-lobe dysfunction in either experimental studies or clinical practice (Homack, Lee & Riccio, 2005). The Trail Making Test consists of a visual cancellation task and a series of connect-the-circle tasks. The five conditions of this test include, condition 1: visual scanning; condition 2: number sequencing; condition 3: letter sequencing; condition 4: number-letter switching and; condtion 5: motor speed. The main part of the test which assesses executive functioning skills is condition 4 (number-letter switching) and is meant to assess flexibility of thinking on a visual-motor sequencing task (Homack et al., 2005). The other four conditions of this test allow an examination of the participant's ability at component skills including visual scanning, number sequencing, letter sequencing, and motor speed. The test is designed in this way so that the examiner can determine whether a deficient score on condition 4 is related to a deficit in cognitive flexibility and/ or to an impairment in one or more of the underlying component skills (Homack et al., 2005). The Trail Making Test is one of the most widely used in neuropsychological assessment (Perianez, Rios-Lago, Rodriguez-Sanchez, Adrover-Roig, Sanchez-Cubillo, Crespo-Facorro, et al., 2007). Test-retest correlations for the various conditions range from 0.38 (condition 4) to 0.77 (condition 5; Delis et al., 2001). The validity of the Trail Making Test has been demonstrated in numerous neuropsychological studies conducted over the past number of decades (Delis et

al., 2001). However, the various versions of the Trail Making Test that are available are vulnerable to practice effects (Buck, Atkinson & Ryan, 2008; Homack et al., 2005; Naglieri & Das, 1997; Reynolds, 2002) and therefore caution should be used in the interpretation of test results.

Difficulties with executive functioning are thought to arise from damage to the frontal lobes (Stuss, 2011) and therefore the Trail-Making test is considered to be sensitive to frontal lobe damage. In addition, injuries to subcortical and other nonfrontal brain structures that have connections to the frontal lobes can produce executive functioning difficulties (Cummings, 1995). Condition 4 of the Trail Making Test places significant demands on cognitive switching, a function associated with the frontal lobes. In addition to executive functioning, Condition 4 of the Trail-Making Test, which involves number-letter switching, requires 'divided attention'; that is, performing two tasks at once. Patients with frontal lesions frequently have difficulty when performing these types of tasks due to difficulties with divided attention (Baddeley, Della Sala, Papagno & Spinnler, 1996).

3.3.3. Sustained Attention Response Task (SART)

The Sustained Attention Response Task (SART; Robertson et al., 1997) is a computer-based task designed to measure a person's ability to inhibit their response to infrequent and unpredictable stimuli while responding to frequent stimuli that are rapidly presented (see test instructions in Appendix C). Participants are presented with random digits (1 to 9) on the computer screen, at a rate of one every 1.15 s. Each digit is presented for 250 ms followed by a 900 ms mask and participants are required to click the mouse when they see a number, apart from when they see the number 3 when they must withhold clicking the mouse. The task consists of a total of 225 trials (25 of each of the 9 digits) and lasts approximately 4.3 min. The primary outcome measure of the SART is the total error score, consisting of commission

errors (clicking the mouse when a number 3 is displayed on screen) and omission errors (failing to click the mouse when a non-3 is displayed on screen). Total accuracy scores relate to the total number of correct responses to presented stimuli, including inhibition of response to the number 3.

Different types of errors on the SART can reflect either attentional drift or resolution of response competition (O'Connell, Dockree, Bellgrove, Turin, Ward, Foxe & Robertson, 2009), both of which are related to failures of sustained attention. The SART provides reaction time data and reaction time is sensitive to frontal brain damage (Stuss et al., 2003).

The SART has been used in many studies with a brain injury population and in a study by Di Rosa, Hannigan, Brennan, Reilly, Rapcan & Robertson (2014), it was found to be free of practice effects. Richard, O'Connor, Dey & Robertson (2018) explored the effects of moderate to severe TBI on activity and functional connectivity in the right-lateralised frontal-subcortical-parietal sustained attention network and the effects of alerting cues. Participants were scanned using fMRI as they performed the SART in 60-second blocks, with or without exogenous cueing through brief auditory alerting tones. When alerting cues were present during the SART functional connectivity increased and became comparable to activity patterns seen in the neurologically healthy control group.

The SART was used in a study by Levine et al. (2011) which investigated an expanded version of Goal Management Training (GMT) by comparing it to an alternative intervention. The SART was used as a measure of 'near transfer' given that GMT employs SART-like tasks. Outcome data indicated specific effects of GMT on the SART and overall, the data supported the efficacy of GMT in the rehabilitation of executive functioning deficits.

Different types of errors on the SART can reflect either attentional drift or resolution of response competition (O'Connell et al., 2009), both of which are related to failures of sustained attention. As the SART provides reaction time data, we also examined the effect of

GMT on variability of response time, which is sensitive to frontal brain damage (Stuss et al., 2003) and associated with indices of integrated brain function in healthy individuals (McIntosh et al.,2008).

Concurrent validity has been established for the SART amongst a group of normal participants (Robertson et al., 1997). A study by Manly, Robertson, Galloway & Hawkins (1999) successfully demonstrated that performance on the SART correlated significantly with everyday life attentional failures.

3.3.4. Digit-Span Task

The Digit Span subtest of the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV; Wechsler, 2008) was used to test working memory and cognitive flexibility (see Appendix D). This test includes Digit Span Forward, Digit Span Backward and Digit Span Sequencing. For Digit Span Forward, the examinee is read a series of numbers and is asked to recall the numbers in the same order. For Digit Span Backward, the examinee is read a sequence of numbers and must recall the numbers in reverse order. For Digit Span Sequencing, the examinee is read a sequence of numbers and must recall the numbers in ascending order.

Each sub-test (forward, backward, sequencing) involves different mental activities and is affected differently by brain damage (Lezak et al., 2012). Studies have shown that the right dorsolateral prefrontal cortex is involved in forward and reversed digit repetition. In addition, bilateral inferior parietal lobule, the anterior cingulate, and medial occipital cortex activate for both digit span forward and backward (Gerton et al., 2004), with the involvement of occipital and parietal areas suggesting the use of a visual imagery strategy (Lezak et al., 2012). The WAIS-IV Manual reports that the split-half reliability coefficient for Digit Span is 0.88 (UK sample) and 0.93 (US sample). Practice effects have been found to be small to

negligible for the Digit Span Test (McCaffrey, Duff and Westervelt, 2000; Wilson, Watson, Baddeley, Emslie, and Evans, 2000).

3.3.5. Community Integration Questionnaire (CIQ)

The Community Integration Questionnaire (CIQ; Willer et al., 1993) consists of 15 items that measures three aspects of community integration: (1) home integration (HI), which includes the ability to perform activities of daily living such as housework, preparing meals, shopping for groceries etc.; (2) social integration (SI), which includes the ability to manage personal finances, participate in leisure activities, visit friends or relatives etc.; and (3) productivity (PA), which includes the frequency of travel outide the home and participation in employment, training or volunteer activities (see Appendix E). Most of the questions are directed at how the individual performs a specific activity within the household or the community. Responses usually indicate that the individual performs the activity alone, with another person, or that the activity is typically performed by someone else. Higher scores indicate greater levels of community integration (range 0-29).

In a systematic review, Reistetter and Abreu (2005) concluded that the CIQ was the best measure of community integration/ participation following brain injury due to its well established validity, reliability and frequency of use. Van Heugten (2017) proposes that the CIQ is a good candidate for use as an outcome measure in research as it has been used and recommended most frequently for use in patients with stroke or TBI and has good psychometric properties. Internal consistency in previous studies has been reported as good, with Cronbach's alpha's ranging from 0.76–0.84 for total scale scores (Corrigan & Deming, 1995) and high test-retest reliability (r = .91; Willer et al., 1993). It has been proposed that community integration is one of the main goals of brain injury rehabilitation (Fortune &

Richards, 2017) and therefore the CIQ was designated as the primary outcome measure for this study.

3.3.6. Satisfaction with Life Scale (SWLS)

The Satisfation with Life Scale (SWLS; Diener, et al., 1985) is a global measure of a person's satisfaction with their life (see Appendix F). The SWLS total score is derived as the sum of the scores from five individual questions, each with responses ranging from 1 (strongly disagree) to 7 (strongly agree) and total SWLS scores range from 5 to 35. A score in the 20-24 range represents average life satisfaction. Internal consistency reliability for this measure has been reported at 0.87, with test-retest reliabilities (two-month interval) ranging from 0.82 to 0.84 (Diener et al., 1985; Pavot, Diener, Colvin, & Sandvick, 1991) and 0.54 for a 4-year interval (Pavot et al., 1991).

3.3.7. Hospital Anxiety and Depression Scale (HADS)

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was used to assess symptoms of distress, including anxiety and depression (see Appendix G). The HADS scale consists of a 14-item measure with items rated on a 0–3 point scale, indicating the strength of agreement with each item. Scores for each subscale range from 0–21. The HADS scale has been widely used in studies with individuas with brain injury and has been shown to be an appropriate measure of anxiety and depression (e.g., Dawkins, Cloherty, Gracey, & Evans, 2006; Schonberger & Ponsford, 2010). According to Zigmond and Snaith (1983) a score of 8 or above indicates possible clinical levels of anxiety or depression, and a score of 11 or above on either subscale is suggestive of probable clinical disorder.

3.3.8. Cognitive Group Self-Evaluation

The Cognitive Group Self-Evaluation Questionnaire is a questionnaire that was designed by a Clinical Neurosychologist in ABI Ireland, for use as part of the Cognitive Group Programme (see Appendix H). It consists of 14 questions regarding difficulties that a person may have following their brain injury (for example memory difficulties or difficuly putting thoughts into words) and asks the person to rate their level of difficulty and the impact it has on their life on a scale from 0 (no difficulty) to 5 (severe difficulty).

3.3.9. Knowledge of Brain Injury Questionnaire

The Knowledge of Brain Injury Questionnaire is a questionnaire that was designed by a Clinical Neuropsychologist in ABI Ireland for use as part of the Cognitive Group Programme (see Appendix I). It consists of 8 statements regarding a person's knowledge of brain injury (for example an understanding of fatigue management or an understanding of strategies for memory problems) and the person completing it circles the level that most applies to them on a 5-point scale, ranging from 'strongly agree' to 'strongly disagree'.

3.4 Ethical Approval for Study

Ethics Committee approval was received from ABI Ireland's Ethics Committee and Maynooth University's Biomedical and Life Sciences Research Ethics Sub-Committee (see Appendix J).

3.5 Participant Recruitment

The research project was advertised amongst potential participants of the Cognitive Group Programmes run by ABI Ireland during 2013 – 2016 in Dublin and Sligo. Potential participants all had an ABI and had been referred to ABI Ireland for services. An advert and

information sheet (see Appendix K) were provided to prospective participants who met the inclusion criteria, in advance of the programme starting, by the programme facilitator. In addition to the inclusion criteria, exclusion criteria were applied as follows: (i) a level of cognition that would prevent the successful completion of questionnaires/ neuropsychological tests; (ii) a level of dysphasia or comprehension difficulty that would prevent the successful completion of questionnaires/ neuropsychological tests; and (iii) presence of a major medical illness unconnected to the acquired brain injury (e.g., cancer, heart disease, rheumatic disease).

The programme facilitator confirmed names of participants that were interested in taking part in the research project to the researcher. The researcher made follow-up phone calls to participants to confirm their participation in the research project and to set up an initial meeting. On the first meeting with the researcher, participants completed a consent form prior to taking part in the study (see Appendix L). The control group consisted of people who were on a waiting list for a Cognitive Group Programme and they were matched with those in the intervention group on gender, age (to within one standard deviation) and type of ABI. Potential control group participants were provided with an advert and information sheet regarding the study by their local Clinical Neuropsychologist. If a person was interested in taking part in the study, the Clinical Neuropsychologist passed on their name and contact details to the researcher.

The researcher met participants in their own home (some participants were living in ABI Ireland Assisted Living services), at a time that was most convenient for them, and administered the neuropsychological tests and questionnaires. Data were collected from participants at three time-points; at induction to the Cognitive Group Programme, at completion of the programme twelve weeks later and at six months follow up. The same three time-points were used for the control group. Note that the intervention group completed four

of the questionnaires (Community Integration Questionnaire, Satisfaction With Life Scale; Cognitive Group Self-Evaluation; and Knowledge of Brain Injury) on week 10 of the Cognitive Group programme as there is more time for this on week 10 and weeks 11 and 12 are taken up with a planned activity organised by participants.

A total of seventy-eight individuals met the inclusion criteria (aged between 18-65 years of age and English a first language) and of that number, thirty-nine individuals agreed to take part in the research project. There was an attrition rate of 18% which resulted in a final number of thirty-two participants in the study, nineteen in the intervention arm and thirteen in the control arm of the study (see Fig. 1 below). Participants were recruited from eight programmes run over four years (2013-2016), seven in Dublin (Dunlaoghaire, Mulhuddart and Lucan) and one in Sligo. The aim was to recruit between 60-70 participants to the study, however due to the number of programmes run during the course of the research study and the numbers of people who expressed an interest in taking part in the research, the actual number in the study was lower than initially anticipated (n=32).

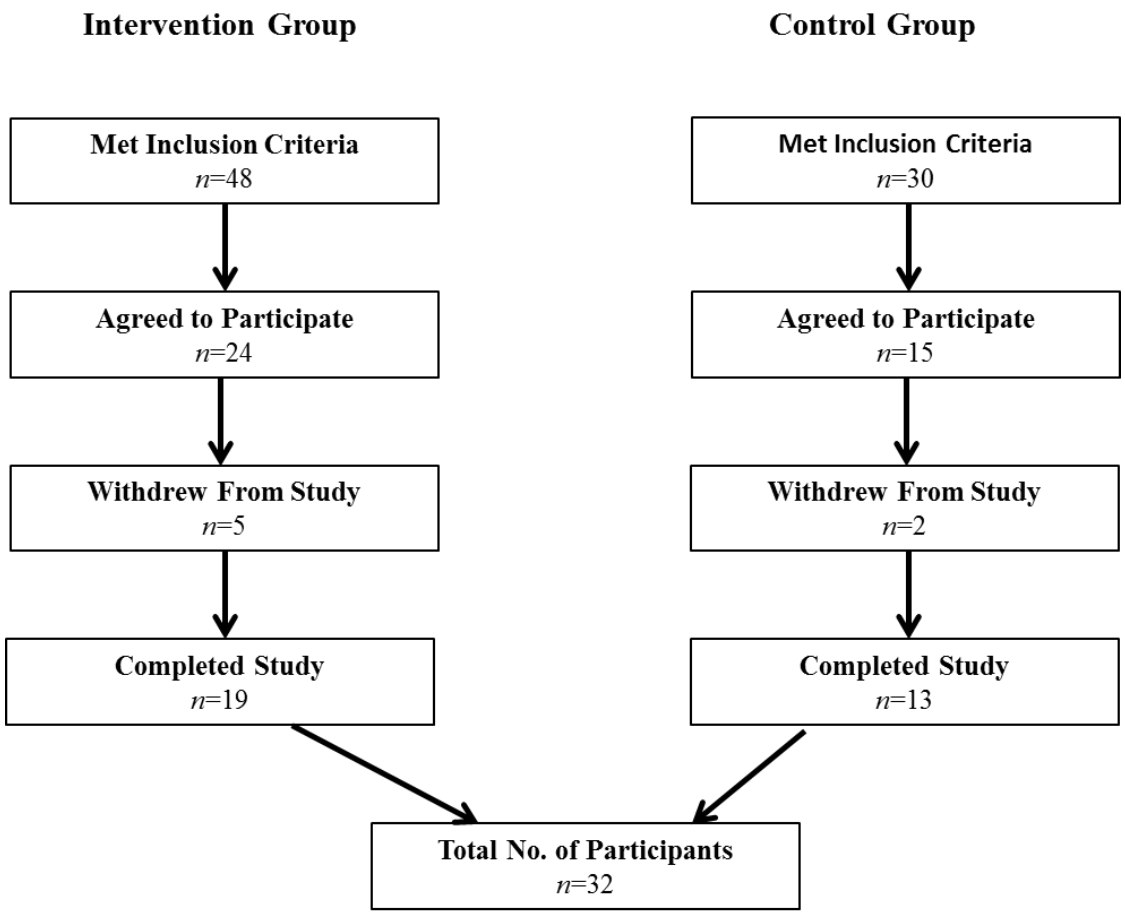

Fig. 3.1 *Participant Recruitment Work-Flow*

3.6 Participants

3.6.1 Intervention Group

There were fifteen males (*n*=15) and four females (*n*=4) in the intervention group and participants were aged between 22 and 61 years (*M*=43.42 yrs*; SD*=11.94). Ten participants had suffered a traumatic brain injury (TBI) (*n*=10), four participants had suffered a cerebrovascular accident (CVA) (*n*=4), including two who had suffered an aneurysm/ brain haemorrhage (*n*=2) and two who had suffered a stroke (*n*=2). Five participants had acquired their brain injury by other means, including cardiac arrest (*n*=2), brain tumour (*n*=2) and

meningitis (*n*=1). The majority (*n*=14) were classified as having a severe brain injury, two as having a moderate brain injury (*n*=2) and three as having a mild brain injury (*n*=3). The mean time since injury was 109 months (*SD*=127.66, range 9-468 months). Fifteen (79%) were unemployed/ retired on ill-health grounds (*n*=15) and four (21%) were employed part-time (*n*=4). The majority of participants were accessing other ABI Ireland services at the time they took part in the research study, including community outreach (32%), case management (26%), assisted living (16%) and Psychology (5%), with 21% receiving no service other than the Cogntive Group Programme. See Table 3.3 and Tables 3.5 - 3.15.

3.6.2 Control Group

The control group consisted of ten males (*n*=10) and three females (*n*=3) and participants were aged between 21 and 60 years (*M*=37.23 yrs*; SD*=13.04). Seven participants had suffered a traumatic brain injury (TBI) (*n*=7) and two participants had suffered a cerebrovascular accident (CVA), including one person who had suffered an aneurysm/ brain haemorrhage (*n*=1) and one person who had suffered a stroke (*n*=1). Four participants had acquired their brain injury by other means, including a diabetic coma (*n*=2), a seizure (*n*=1) and encephalitis (*n*=1). The majority (*n*=10) were classified as having a severe brain injury, two had a moderate brain injury (*n*=2) and one had a mild brain injury (*n*=1). The average time since injury was 149 months (*SD*=162.43, range 24-606 months). Nine (69%) were unemployed (*n*=9) and four (31%) were gainfully employed in part-time work, volunteer work or as a student (*n*=4). The majority of participants were accessing ABI Ireland services at the time they took part in the research study, including community outreach (46%), assisted living (15%), case management (8%) and Psychology (8%), with 23% not receiving any service. See Table 3.4 and Tables 3.5 - 3.15.

Table 3.3: *Descriptive Statistics for Demographic Variables (Intervention Group)*

		Participants (*N*=19)	
Gender	Male	15	(79%)
	Female	4	(21%)
Age	Mean (SD)	43.42 yrs	(11.94)
Age (Grouped)	39 years or less	8	(42%)
	40 years and over	11	(58%)
Time since injury (months)	Mean (SD)	109 months	(127.66)
Time since injury (Grouped)	≤12 months	2	(10.5%)
	≤24 months	2	(10.5%)
	24-121 months	9	(47%)
	+121 months	6	(32%)
Injury Severity	Mild	3	(16%)
	Moderate	2	(10%)
	Severe	14	(74%)
Type of ABI	RTA (TBI)	6	(32%)
	Stroke (CVA)	2	(10.5%)
	Assault/Hit By Object (TBI)	2	(10.5%)
	Brain Haemorrhage/ Aneurysm (CVA)	2	(10.5%)
	Fall (TBI)	2	(10.5%)
	Cardiac Arrest	2	(10.5%)
	Brain Tumour	2	(10.5%)
	Meningitis	1	(5%)
Type of ABI (Grouped)	TBI (Traumatic Brain Injury)	10	(53%)
	CVA (Cerebrovascular Accident)	4	(21%)
	Other	5	(26%)
Employment Status	P/T Employed	4	(21%)
	Unemployed	14	(74%)
	Retired	1	(5%)
Employment Status (Grouped)	Unemployed/ Retired ill-health	15	(79%)
	Gainful Activity	4	(21%)

Relationship Status	Single	10	(53%)
	Married	6	(32%)
	Co-habiting	1	(5%)
	Separated/Divorced	2	(10%)
Living Status	Alone	2	(10.5%)
	With family	10	(53%)
	Supported living	4	(21%)
	With partner	1	(5%)
	Shared Accommodation	2	(10.5%)
Occupation prior to injury	Manufacturing	1	(5.3%)
	Building/Construction	2	(10.5%)
	Clerical/Management/Government	3	(15.8%)
	Communication & Transport	1	(5.3%)
	Sales & Commerce	1	(5.3%)
	Professional, Technical & Health	5	(26.3%)
	Service Work	2	(10.5%)
	Other	4	(21.1%)
Education Level	Junior/Inter Cert/O Level	4	(21%)
	Leaving Cert/A Level	1	(5%)
	Third Level Education	10	(53%)
	Left school early	3	(16%)
	Special Needs Education	1	(5%)
Years of Education	Mean (SD)	14.37	(3.62)
Service Accessed	Assisted Living	3	(16%)
	Community Outreach	6	(32%)
	Case Management	5	(26%)
	Psychology	1	(5%)
	Cognitive Group Only	4	(21%)

Table 3.4: *Descriptive Statistics for Demographic Variables (Control Group)*

		Participants (*N*=13)	
Gender	Male	10	(77%)
	Female	3	(23%)
Age	Mean (SD)	37.23 yrs	(13.04)
Age (Grouped)	39 years or less	8	(61.5%)
	40 years and over	5	(38.5%)
Time since injury (months)	Mean (SD)	149months	(162.43)
Time since injury (grouped)	≤12 months	0	(0%)
	≤24 months	2	(15.4%)
	25-120 mths	6	(46.2%)
	+120 mths	5	(38.5%)
Injury Severity	Mild	1	(8%)
	Moderate	2	(15%)
	Severe	10	(77%)
Type of ABI	RTA (TBI)	4	(30.8%)
	Stroke (CVA)	1	(7.7%)
	Assault/Hit By Object (TBI)	1	(7.7%)
	Brain Haemorrhage/ Aneurysm (CVA)	1	(7.7%
	Fall (TBI)	2	(15.4%)
	Diabetic Coma	2	(15.4%)
	Seizure	1	(7.7 %)
	Encephalitis	1	(7.7%)
Type of ABI (Grouped)	TBI (Traumatic Brain Injury)	7	(54%)
	CVA (Cerebrovascular Accident)	2	(15%)
	Other	4	(31%)
Employment Status	P/T Employed	2	(15.4%)
	Unemployed	9	(69.2%)
	Volunteer Work	1	(7.7%)
	Student	1	(7.7%)

Employment Status (Grouped)	Unemployed/ Retired ill-health	9	(69%)
	Gainful Activity	4	(31%)
Relationship Status	Single	11	(85%)
	Married	2	(15%)
Living Status	Alone	4	(31%)
	With family	6	(46%)
	Supported living	3	(23%)
Occupation prior to injury	Manufacturing	1	(7.7%)
	Clerical/Management/ Government	2	(15.4%)
	Sales & Commerce	1	(7.7%)
	Professional, Technical & Health	2	(15.4%)
	Service Work	1	(7.7%)
	Other	6	(46.2%)
Education Level	Junior/Inter Cert/O Level	2	(15.4%)
	Leaving Cert/A Level	3	(23.1%)
	Third Level Education	5	(38.5%)
	Left school early	3	(23.1%)
Years of Education	Mean (SD)	14.08	(2.27)
Service Accessed	Assisted Living	2	(15%)
	Community Outreach	6	(46%)
	Case Management	1	(8%)
	Psychology	1	(8%)
	None	3	(23%)

Table 3.5: *Descriptive Statistics Comparison Between Groups: Gender*

	Male	**Female**
Intervention	15 (79%)	4 (21%)
Control	10 (77%)	3 (23%)
Comment: There was no significant difference between the two groups in relation to gender (p = 1, Fisher's Exact Test).		

Table 3.6: *Descriptive Statistics Comparison Between Groups: Age*

	Age
Intervention	*M*=43.42 yrs (*SD*=11.94) 39 years or less = 8 (42%) 40 years and over = 11 (58%)
Control	*M*=37.23 yrs (*SD*=13.04) 39 years or less = 8 (61.5%) 40 years and over = 5 (38.5%)
Comment: The control group had a higher percentage (61.5%) of younger participants (39 years or less) when compared to the intervention group where 42% were 39 years or less. Chi square analysis showed no significant difference between the two groups in relation to age groups [$\chi^2(1)=.52$, $p=.47$].	

Table 3.7: *Descriptive Statistics Comparison Between Groups: Time Since Injury*

	Time Since Injury
Intervention	*M* =109 months (9 years) *SD*=127.66 ≤12 months = 2 (10.5%) ≤24 months = 2 (10.5%) 24-121 months = 9 (47%) +121 months = 6 (32%)
Control	*M*=149 months (12 years) *SD*=162.43 ≤24 months = 2 (15.4%) 24-121 months = 6 (46.2%) +121 months = 5 (38.5%)
Comment: The mean time since injury was slightly higher in the control group (149 months) then the intervention group (109 months). The intervention group had a higher percentage (21%) of participants in the ≤24 months category when compared to the control group which had 15.4% in this category.	

Table 3.8: *Descriptive Statistics Comparison Between Groups: Injury Severity*

	Mild	**Moderate**	**Severe**
Intervention	3 (16%)	2 (10%)	14 (74%)
Control	1 (8%)	2 (15%)	10 (77%)
Comment: The control group had a slightly higher percentage of participants with a severe brain injury (77%) when compared to the intervention group (74%) as well as a higher percentage of participants with a moderate brain injury (15%) when compared to the intervention group (10%). The intervention group had a higher percentage of participants with a mild brain injury (16%) when compared to the control group (8%).			

Table 3.9: *Descriptive Statistics Comparison Between Groups: Type of ABI (Grouped)*

	TBI	**CVA**	**Other**
Intervention	10 (53%)	4 (21%)	5 (26%)
Control	7 (54%)	2 (15%)	4 (31%)
Comment: The intervention group had a higher percentage of participants in the CVA category (21%) when compared to the control group (15%) and the control group had a higher percentage of participants in the 'other' category (31%) when compared to the intervention group (26%).			

Table 3.10: *Descriptive Statistics Comparison Between Groups: Employment Status*

	Unemployed/ Retired ill-health	**Gainful Activity**
Intervention	15 (79%)	4 (21%)
Control	9 (69%)	4 (31%)
Comment: The control group had a higher percentage of participants engaged in gainful activity (31%) when compared to the intervention group (21%). There was no significant difference between the two groups in relation to employment status (p = .68, Fisher's Exact Test).		

Table 3.11: *Descriptive Statistics Comparison Between Groups: Relationship Status*

	Single	**Married**	**Co-habiting**	**Separated/Divorced**
Intervention	10 (53%)	6 (32%)	1 (5%)	2 (10%)
Control	11 (85%)	2 (15%)		
Comment: The control group had a higher number of single people (85%) when compared to the intervention group (53%) and there were more married and co-habiting people in the intervention group (37%) when compared to the control group (15%). Chi-square analysis comparing the two groups in relation to relationship status (single or married/co-habiting) showed no significant difference between the groups (p = .23, Fisher's Exact Test).				

Table 3.12: *Descriptive Statistics Comparison Between Groups: Living Status*

	Alone	With Family	Supported Living	With Partner	Shared Accommodation
Intervention	2 (10.5%)	10 (53%)	4 (21%)	1 (5%)	2 (10.5%)
Control	4 (31%)	6 (46%)	3 (23%)		
Comment: The control group had a higher percentage of participants living alone (31%) than the intervention group (10.5%) and the intervention group had a higher percentage of participants living with family or with a partner (58%) when compared to the control group (46%). Both groups had a similar percentage of participants in supported living, with 21% of the intervention group in this category and 23% of the control group.					

Table 3.13: *Descriptive Statistics Comparison Between Groups: Occupation Prior to Injury*

	Man'g	Build/ Const	Clerical/ Mgt/ Govt	Comm & T/port	Sales & Comm	Prof/ Tech/ Health	Service	Other
Int	1 (5.3%)	2 (10.5%)	3 (15.8%)	1 (5.3%)	1 (5.3%)	5 (26.3%)	2 (10.5%)	4 (21.1%)
Ctl	1 (7.7%)		2 (15.4%)		1 (7.7%)	2 (15.4%)	1 (7.7%)	6 (46.2%)
Comment: The intervention group had a higher percentage of participants in the professional/technical/health category (26.3%) than the control group (15.4%) and the control group had a higher percentage of participants in the 'other' category (46.2%) when compared to the intervention group (21.1%).								

Table 3.14: *Descriptive Statistics Comparison Between Groups: Education Level*

	Junior/Inter Cert/O Level	Leaving Cert/A Level	Third Level Education	Left School Early	Special Needs Education
Intervention	4 (21%)	1 (5%)	10 (53%)	3 (16%)	1 (5%)
Control	2 (15.4%)	3 (23.1%)	5 (38.5%)	3 (23%)	
Comment: The intervention group had a higher level of education with 53% of this group completing 3rd level education in comparison to 38.5% of the control group. 23% of control group participants left school early in comparison to 16% of the intervention group.					

Table 3.15: *Descriptive Statistics Comparison Between Groups: Service Accessed*

	Assisted Living	Community Outreach	Case Management	Psychology	Cognitive Group Only	None
Int	3 (16%)	6 (32%)	5 (26%)	1 (5%)	4 (21%)	0
Ctl	2 (15%)	6 (46%)	1 (8%)	1 (8%)	0	3 (23%)
Comment: The control group had a higher number of people accessing community outreach (46%) than the intervention group (32%) and the intervention group had a higher number of people accessing case management (26%) than the control group (8%). 23% (*n*=3) of the control group were accessing no services.						

3.7 Statistical Analysis

Data were screened for normality, skewness, kurtosis and to check for outliers. Checks were also made for homogeneity of variance. Baseline data was compared with normative data for tests, where available, and group differences for timepoint 1 were examined using Mann-Whitney U tests, t-tests and chi-square analysis. Due to the different sample sizes in each group (19 in the intervention group and 13 in the control group), non-parametric tests were used in addition to parametric tests (multifactorial ANOVA and post hoc Bonferroni-corrected t-tests). Effect sizes were examined where significant differences were found.

Within group differences were examined using Wilcoxon tests (chapter 5 and 6) and Friedman tests (chapter 7). These tests assessed for changes across the three timepoints in addition to short-term (T1 v T2) and longitudinal effects (T1 v T3 and T2 v T3) . Between group differences were examined using Mann-Whitney U tests, multifactorial ANOVA and post hoc Bonferroni-corrected t-tests (chapter 7). Within groups factor was timepoint (pre-intervention, post-intervention and 6 months later), and dependent measures were the dependent variables for each of the tests and questionnaires used in the study.

Correlation analysis was conducted on the main dependent variables and the continuous demographic variables of age, time since injury and years of education. Correlation analysis was also conducted on the main dependent variables for neuropsychological measures (including the Cognitive Self Evaluation measure) and the mood variables of anxiety, depression and distress (anxiety and depression combined). SPSS version 22 was used for all statistical analyses.

Chapter 4

Baseline Data - Timepoint 1

4.1 Introduction

Neuropsychological tests and questionnaires were administered to the intervention group at three timepoints. Timepoint 1 was on the first day of the Cognitive Group Programme, timepoint 2 was twelve weeks later on completion of the programme (except for some questionnaires which were administered at week 10 – see details below) and timepoint 3 was six months after completion of the programme. The same intervals were used for the control group, with timepoint 1 being the first visit to the participant to complete tests and questionnaires, timepoint 2 was 12 weeks later and timepoint 3 was six months later. The intervention group completed the following questionnaires at week 10 due to time constraints on week 11 and 12: Community Integration Questionnaire, Satisfation with Life Scale, Cognitive Group Self-Evaluation Questionnaire and Knowledge of Brain Injury Questionnaire. The battery of tests and questionnaires used is as follows:

1. California Verbal Learning Test-Second Edition (CVLT-II; Delis et al., 2000)
2. Trail Making Test from the Delis-Kaplan Executive Function System (D-KEFS; Delis et al., 2001)
3. Sustained Attention Response Task (SART; Robertson et al., 1997)
4. Digit Span subtest of the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV; Wechsler, 2008)
5. Community Integration Questionnaire (CIQ; Willer et al., 1993)
6. Satisfation with Life Scale (SWLS; Diener, et al., 1985)
7. Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983)
8. Cognitive Group Self-Evaluation Questionnaire (developed by a Senior Clinical Neuropsychologist in ABI Ireland)
9. Knowledge of Brain Injury Questionnaire (developed by a Senior Clinical Neuropsychologist in ABI Ireland)

4.2 Data Analysis

Data were screened for skewness, kurtosis and to check for outliers. Checks were also made for homogeneity of variance. Baseline (T1) scores for the dependent variables were compared with normative data (where available) for both groups. Group differences for timepoint 1 were examined using Mann-Whitney U tests, t-tests and chi-square analysis. SPSS version 22 was used for all statistical analyses.

4.3 California Verbal Learning Test: Baseline Comparison with Normative Data and Between Group Comparison (By Gender and Age Group) at T1

Baseline (T1) mean scores on the CVLT-II subscales were compared with normative data for both groups. Normative data was obtained from the CVLT-II manual (Delis et al., 2000). In order to make comparisons with the normative data, the two groups (intervention and control) were further divided by gender and age group. Between group differences were examined for each age group using Mann-Whitney U tests or t-tests (except where there was only one participant in a particular age group and therefore mean scores were not available).

For Total Free Recall scores, a higher score indicates more words recalled, and therefore better performance. On the intrusions and repetitions subscales, a lower z score indicates better performance due to less intrusions or repetitions being made. On the Learning Slope and Semantic Clustering measures, a higher z score indicates better performance.

4.3.1. Baseline vs Normative Data: Males Aged 20-29

On the Total Free Recall measure, the intervention group scored lower than the normative data (18.2 points) and the control group also scored lower than the the normative data (30.6 points) on this measure (See Table 4.1 and Fig 4.1).

On the Intrusions (z score) measure, the intervention group scored lower than the the normative data (0.5 points) and the control group scored higher than the the normative data

(0.8 points) on this measure. On the Repetitions (z score) measure, the intervention group scored the same as the normative data and the control group scored higher than the normative data (0.6 points) on this measure. On the Learning Slope (z score) measure, the intervention group scored lower than the normative data (1.5 points) and the control group also scored lower than the normative data (1.1 points) on this measure. On the Semantic Clustering (z score) measure, the intervention group scored higher than the normative data (0.5 points) and the control group scored lower than the normative data (0.1 points) on this measure. See Table 4.1 and Fig 4.2. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.2.

Table 4.1 *CVLT-II Baseline vs Normative Data: Males Aged 20-29*

	Intervention (Baseline) *N*=1	**Control (Baseline) *N*=5**	**Normative Data**
Total Free Recall	55	*M* 42.6	73.2
Intrusions z score	-.5	*M* .8	0
Repetitions z score	0	*M* .6	0
Learning Slope z score	-1.5	*M* -1.1	0
Semantic Clustering z score	.5	*M* -.1	0

Table 4.2 *CVLT-II Baseline vs Normative Data (Frequencies): Males Aged 20-29*

	Intervention (Baseline) ***N*=1**			**Control (Baseline)** ***N*=5**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Free Recall	1	0	0	5	0	0
Intrusions z score	0	0	1	3	1	1
Repetitions z score	1	0	0	2	1	2
Learning Slope z score	1	0	0	3	1	1
Semantic Clustering z score	0	0	1	1	4	0

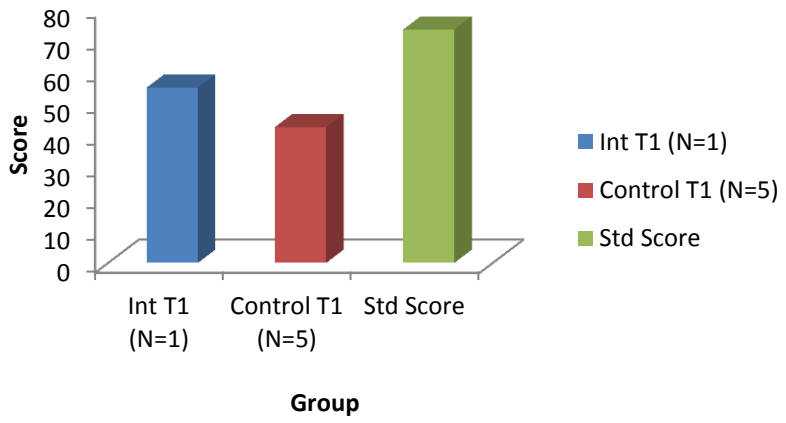

Fig. 4.1 *Total Free Recall Scores (Baseline v Normative Data): Males Aged 20-29*

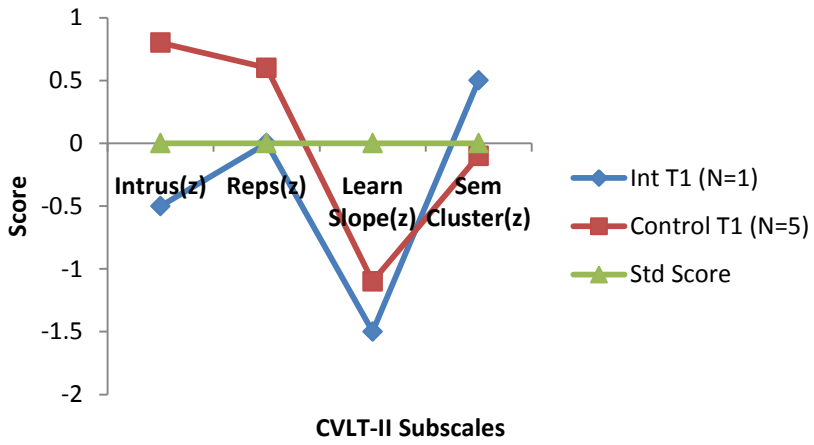

Fig. 4.2 *CVLT-II Subscale Scores (Baseline v Normative Data): Males Aged 20-29*

4.3.2. Baseline vs Normative Data: Males Aged 30-44

On the Total Free Recall measure, the intervention group scored lower than the normative data (30.3 points) and the control group also scored lower than the normative data (58.5 points) on this measure. See Table 4.3 and Fig 4.3.

On the Intrusions (z score) measure, the intervention group scored lower than the normative data (0.4 points) and the control group scored higher than the normative data (1.5 points) on this measure. On the Repetitions (z score) measure, the intervention group scored higher than the normative data (1.8 points) and the control group scored lower than the normative data (1.5 points) on this measure. On the Learning Slope (z score) measure, the intervention group scored lower than the normative data (0.4 points) and the control group also scored lower than the normative data (2 points) on this measure. On the Semantic Clustering (z score) measure, the intervention group scored lower than the normative data (0.3 points) and the control group scored lower than the normative data (1 point) on this measure. See Table 4.3 and Fig 4.4. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.4

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Table 4.3 *CVLT-II Baseline vs Normative Data:Males Aged 30-44*

	Intervention (Baseline) *N*=5	**Control (Baseline) *N*=1**	**Normative Data**
Total Free Recall	*M* 51.2	23	81.5
Intrusions z score	*M* -.4	1.5	0
Repetitions z score	*M* 1.8	-1.5	0
Learning Slope z score	*M* -.4	-2	0
Semantic Clustering z score	*M* -.3	-1	0

Table 4.4 *CVLT-II Baseline vs Normative Data (Frequencies): Males Aged 30-44*

	Intervention (Baseline) *N*=5			**Control (Baseline) *N*=1**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Free Recall	5	0	0	1	0	0
Intrusions z score	0	2	3	1	0	0
Repetitions z score	4	1	0	0	0	1
Learning Slope z score	3	0	2	1	0	0
Semantic Clustering z score	3	1	1	1	0	0

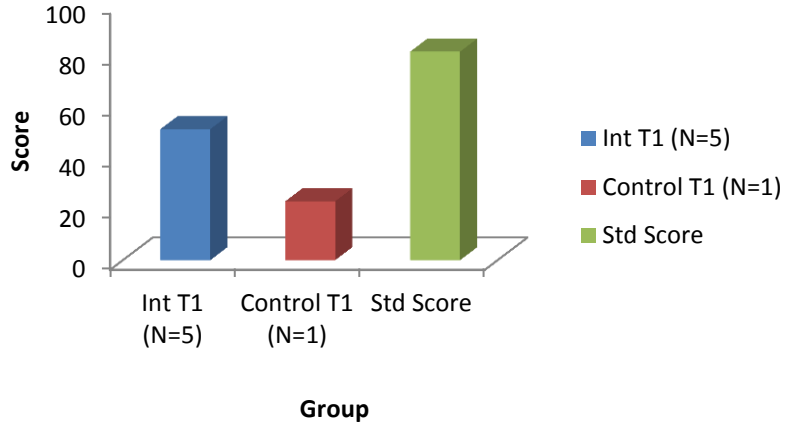


Fig. 4.3 *Total Free Recall Scores (Baseline v Normative Data): Males Aged 30-44*

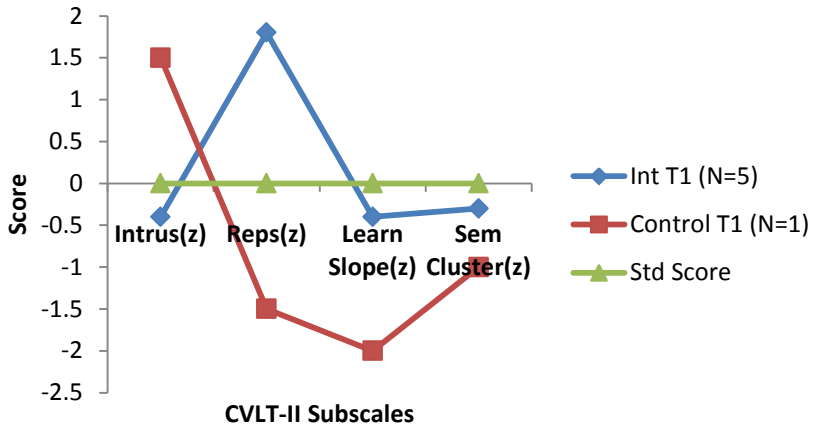


Fig. 4.4 *CVLT-II Subscale Scores (Baseline v Normative Data): Males Aged 30-44*

4.3.3. Between Groups Comparison at T1 and Baseline vs Normative Data: Males Aged 45-59

On the Total Free Recall measure, the intervention group scored lower than the normative data (42.4 points) and the control group also scored lower than the normative data (36 points) on this measure (see Table 4.5 and Fig. 4.5). A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Total Free Recall T1 [*U*=-1.03, p=.31]. See Table 4.5 and Fig. 4.5.

On the Intrusions (z score) measure, the intervention group scored higher than the normative data (1.07 points) and the control group also scored higher than the normative data (0.5 points) on this measure. A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Intrusions (z score) T1 [*U*=-.83, p=.41]. On the Repetitions (z score) measure, the intervention group scored the same as the normative data and the control group scored lower than the normative data (.17 points) on this measure. A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Repetitions (z score) T1 [*U*=-.12, p=.91]. See Table 4.5 and Fig. 4.6.

On the Learning Slope (z score) measure, the intervention group scored lower than the normative data (0.36 points) and the control group also scored lower than the normative data (1.33 points) on this measure. A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Learning Slope (z score) T1 [*U*=-1.64, p=.10]. On the Semantic Clustering (z score) measure, the intervention group scored lower than the normative data (0.79 points) and the control group also scored lower than the normative data (0.33 points) on this measure. A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Semantic Clustering (z score) T1 [*U*=-1.89, p=.06]. See Table 4.5 and Fig. 4.6. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.6.

Table 4.5 ***CVLT-II Between Groups Comparison at T1 and Baseline vs Normative Data: Males Aged 45-59***

	Intervention (Baseline) *N*=7	**Control (Baseline) *N*=3**	**Normative data**	***U***	***p***
Total Free Recall	*M* 29.76	*M* 36	72	-1.03	.31
Intrusions z score	*M* 1.07	*M* 0.5	0	-.83	.41
Repetitions z score	*M* 0	*M* -.17	0	-.12	.91
Learning Slope z score	*M* -.36	*M* -1.33	0	-1.64	.10
Semantic Clustering z score	*M* -.79	*M* -.33	0	-1.89	.06

*$p<0.05$ ** $p<0.01$

Table 4.6 *CVLT-II Baseline vs Normative Data (Frequencies): Males Aged 45-59*

	Intervention (Baseline) *N*=7			**Control (Baseline) *N*=3**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Free Recall	7	0	0	3	0	0
Intrusions z score	5	1	1	2	0	1
Repetitions z score	2	2	3	0	2	1
Learning Slope z score	5	0	2	3	0	0
Semantic Clustering z score	7	0	0	2	1	0

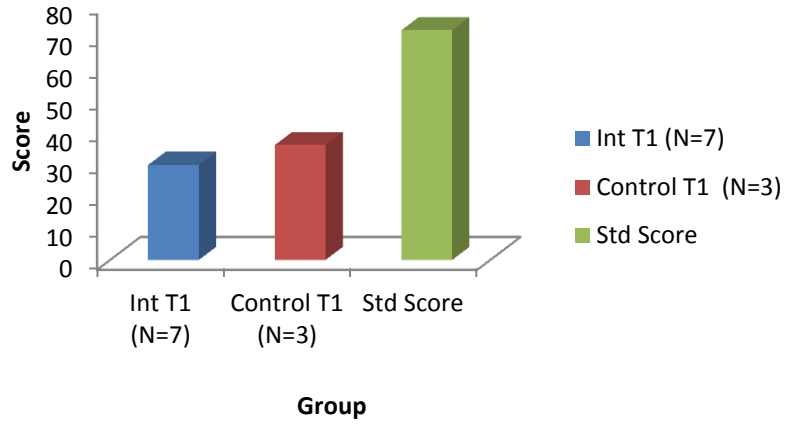


Fig. 4.5 *Total Free Recall Scores (**Between Groups Comparison and** Baseline v Normative Data): Males Aged 45-59*

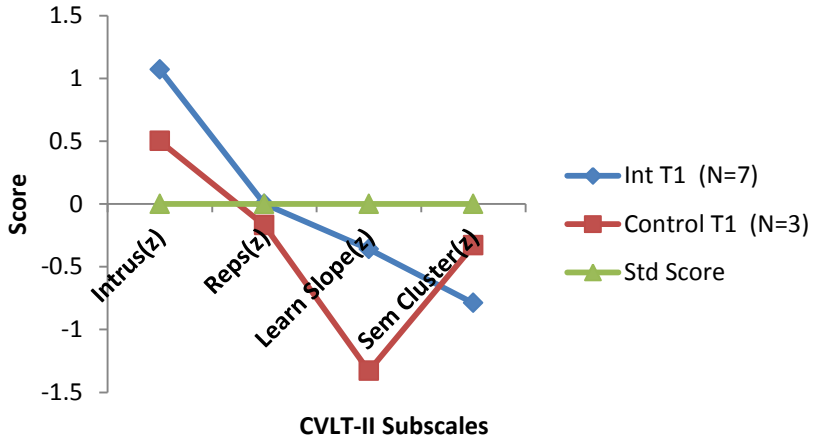


Fig. 4.6 *CVLT-II Subscale Scores (**Between Groups Comparison and** Baseline v Normative Data): Males Aged 45-59*

4.3.4. Baseline vs Normative Data: Males Aged 60-69

On the Total Free Recall measure, the intervention group scored lower than the normative data (27 points) and the control group also scored lower than the normative data (31 points) on this measure (see Table 4.7 and Fig. 4.7).

On the Intrusions (z score) measure, the intervention group scored lower than the normative data (1 point) and the control group scored the same as the normative data on this

measure. On the Repetitions (z score) measure, the intervention group scored lower than the normative data (0.5 points) and the control group scored higher than the normative data (0.5 points) on this measure. On the Learning Slope (z score) measure, the intervention group scored lower than the normative data (0.5 points) and the control group also scored lower than the normative data (0.5 points) on this measure. On the Semantic Clustering (z score) measure, the intervention group scored the same as the normative data and the control group scored higher than the normative data (1 point) on this measure. See Table 4.7 and Fig. 4.8. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.8.

Table 4.7 *CVLT-II Baseline vs Normative Data: Males Aged 60-69*

	Intervention (Baseline) *N*=1	**Control (Baseline) *N*=1**	**Normative data**
Total Free Recall	38	34	65
Intrusions z score	-1	0	0
Repetitions z score	-.5	.5	0
Learning Slope z score	-.5	-.5	0
Semantic Clustering z score	0	1	0

Table 4.8 *CVLT-II Baseline vs Normative Data (Frequencies): Males Aged 60-69*

	Intervention (Baseline) ***N*=1**			**Control (Baseline)** ***N*=1**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Free Recall	1	0	0	1	0	0
Intrusions z score	0	0	1	0	1	0
Repetitions z score	0	0	1	1	0	0
Learning Slope z score	1	0	0	1	0	0
Semantic Clustering z score	0	0	1	0	1	0

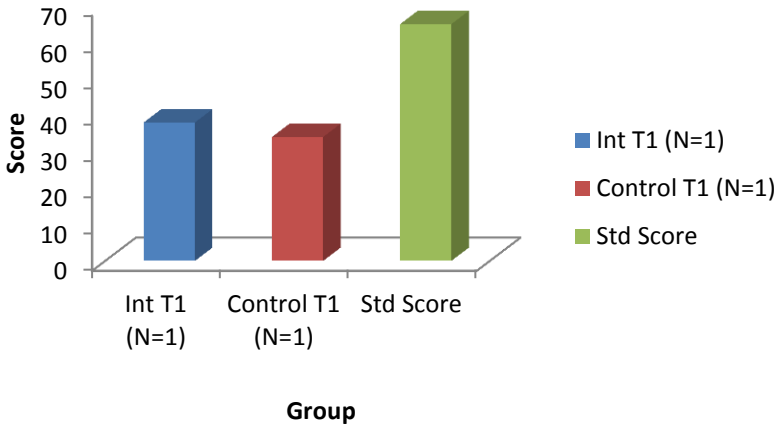


Fig. 4.7 *Total Free Recall Scores (Baseline v Normative Data): Males Aged 60-69*

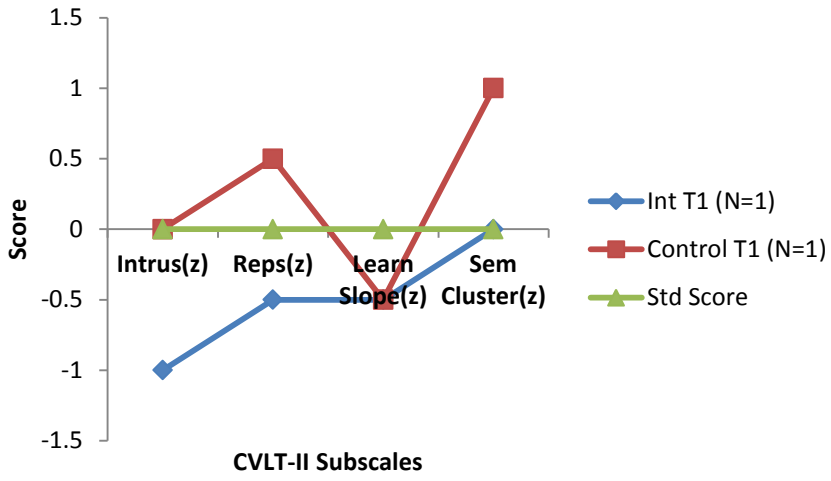


Fig. 4.8 *CVLT-II Subscale Scores (Baseline v Normative Data): Males Aged 60-69*

4.3.5. Between Groups Comparison at T1 and Baseline vs Normative Data: Females Aged 30-44

On the Total Free Recall measure, the intervention group scored lower than the normative data (56 points) and the control group also scored lower than the normative data (49.83 points) on this measure. An independent samples t-test revealed no significant difference between the two groups on baseline Free Recall scores [$t(4) = -1.59$, $p=.19$, 2-tailed]. See Table 4.9 and Fig. 4.9.

On the Intrusions (z score) measure, the intervention group scored higher than the normative data (0.63 points) and the control group also scored higher that the normative data (0.5 points) on this measure. An independent samples t-test revealed no significant difference between the two groups on baseline Intrusions (z score) [$t(4) = .66$, $p=.55$, 2-tailed]. On the Repetitions (z score) measure, the intervention group scored lower than the normative data (0.25 points) and the control group scored higher than the normative data (0.33 points) on this measure. An independent samples t-test revealed no significant difference between the two groups on baseline Repetitions (z score) [$t(4) = -.80$, $p=.47$, 2-tailed]. See Table 4.9 and Fig. 4.10.

On the Learning Slope (z score) measure, the intervention group scored lower than the normative data (1.5 points) and the control group also scored lower than the normative data (1.33 points) on this measure. An independent samples t-test revealed no significant difference between the two groups on baseline Learning Slope (z score) [$t(4) = 0$, $p=1$, 2-tailed]. On the Semantic Clustering (z score) measure, the intervention group scored lower than the normative data (0.88 points) and the control group also scored lower than the normative data (0.67 points) on this measure. An independent samples t-test revealed no significant difference between the two groups on baseline Semantic Clustering (z score) [$t(2) = -1$, $p=.42$, 2-tailed]. See Table 4.9 and Fig. 4.10. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.10.

Table 4.9 ***CVLT-II Between Groups Comparison at T1 and Baseline vs Normative Data: Females Aged 30-44***

	Intervention (Baseline) *N*=3	**Control (Baseline) *N*=3**	**Normative Data**	***t***	***p***
Total Free Recall	*M* 32.5	*M* 38.67	88.5	-1.59	.19
Intrusions z score	*M* .63	*M* .5	0	.66	.55
Repetitions z score	*M* -.25	*M* .33	0	-.80	.47
Learning Slope z score	*M* -1.5	*M* -1.33	0	0	1
Semantic Clustering z score	*M* -.88	*M* -.67	0	-1	.42

*$p<0.05$ ** $p<0.01$

Table 4.10 *CVLT-II Baseline vs Normative Data (Frequencies): Females Aged 30-44*

	Intervention (Baseline) ***N*=3**			**Control (Baseline)** ***N*=3**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Free Recall	3	0	0	3	0	0
Intrusions z score	2	1	0	1	2	0
Repetitions z score	0	2	1	1	1	1
Learning Slope z score	3	0	0	3	0	0
Semantic Clustering z score	3	0	0	2	1	0

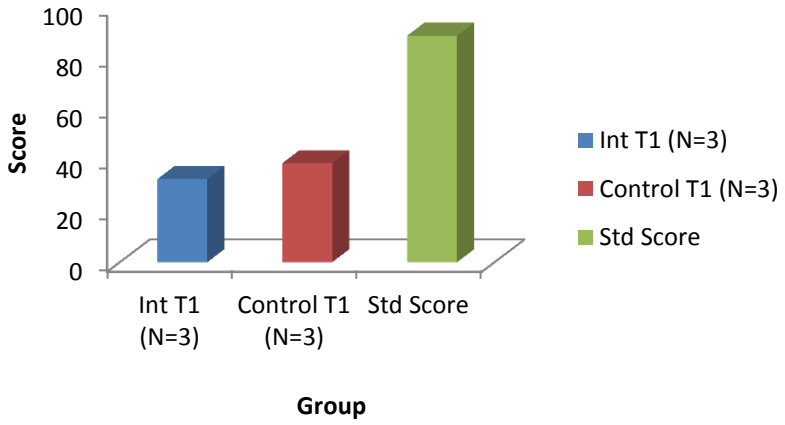


Fig. 4.9 *Total Free Recall Scores (**Between Groups Comparison at T1 and** Baseline v Normative Data): Females Aged 30-44*

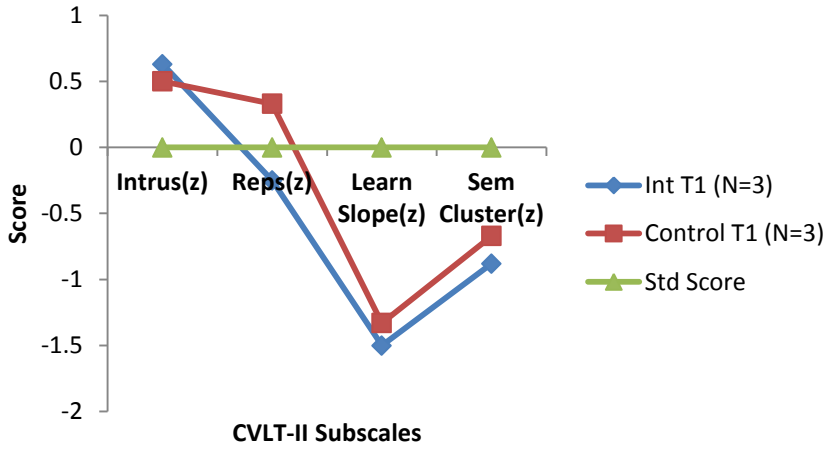


Fig. 4.10 *CVLT-II Subscale Scores (**Between Groups Comparison at T1 and** Baseline v Normative Data): Females Aged 30-44*

4.3.6. Baseline vs Normative Data: Females Aged 45-59

In this age group (45-59 years), there was only participant from the intervention group and none from the control group. The participant from the intervention group scored lower than the normative data on Total Free Recall (29.5 points), Intrusions (z score) (0.5 points), Repetitions (z score) (0.5 points), Learning Slope (z score) (2 points) and Semantic Clustering (z score) (0.5 points). See Table 4.11, Fig. 4.11 and Fig. 4.12.

Table 4.11 *CVLT-II Baseline vs Normative Data for Intervention Group: Females Aged 45-59*

	Intervention (Baseline) *N*=1	**Normative data**
Total Free Recall	51	80.5
Intrusions z score	-.5	0
Repetitions z score	-.5	0
Learning Slope z score	-2	0
Semantic Clustering z score	-.5	0

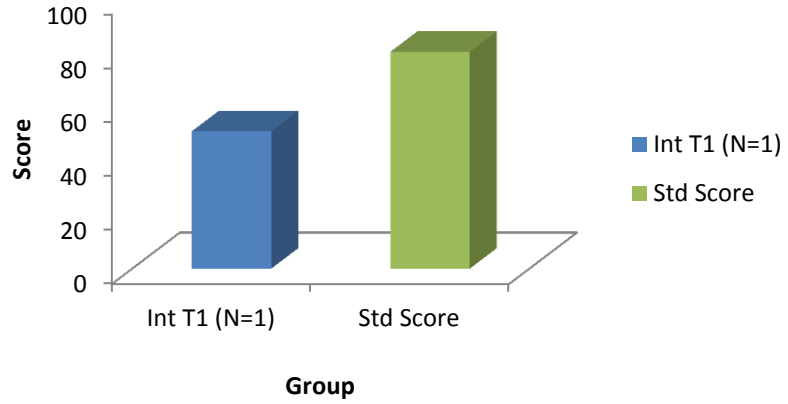


Fig. 4.11 *Total Free Recall Scores (Baseline v Normative Data): Females Aged 45-59*

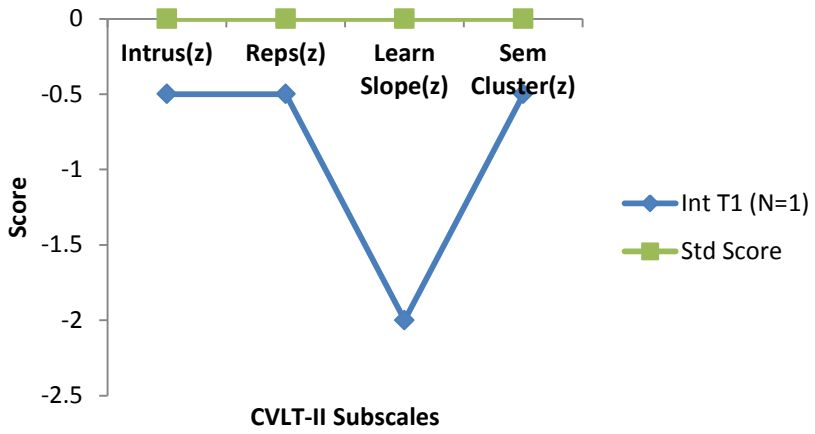


Fig. 4.12 *CVLT-II Subscale Scores (Baseline v Normative Data): Females Aged 45-59*

4.4 California Verbal Learning Test: Between Group Comparison at T1 (All Age Groups)

4.4.1. Between Group Comparison at T1 (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Total Free Recall T1 [*U*=-.30, p=.76], Intrusions (z score) T1 [*U*=-.96, *p*=.34], Repetitions (z score) T1 [*U*=-.33, *p*=.74], Learning Slope (z score) T1 [*U*=-.74, *p*=.46] or Semantic Clustering (z score) T1 [*U*=-1.24, *p*=.22] (see Table 4.12).

Table 4.12 *CVLT-II Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Intervention (Baseline)	**Control (Baseline)**	***U***	***p***
Total Free Recall	*M* 38.18 *SD* 15.82 (*N*=18)	*M* 38 *SD* 12.44 (*N*=13)	-.30	.76
Intrusions z score	*M* .41 *SD* 1.09 (*N*=17)	*M* .71 *SD* 1.03 (*N*=12)	-.96	.34
Repetitions z score	*M* .41 *SD* 1.44 (*N*=17)	*M* .21 *SD* 1.18 (*N*=12)	-.33	.74
Learning Slope z score	*M* -.69 *SD* 1.24 (*N*=18)	*M* -1.17 *SD* 1.42 (*N*=12)	-.74	.46
Semantic Clustering z score	*M* -.5 *SD* .62 (*N*=18)	*M* -.29 *SD* .40 (*N*=12)	-1.24	.22

* p<0.05 ** p<0.01

4.5 Trail Making Test: Baseline Comparison with Normative Data

4.5.1. Baseline vs Normative Data

Baseline (T1) scaled scores for Conditions 1-5 and Condition 4 All Errors for both groups were compared with normative data obtained from Delis et al., 2001. Higher scaled scores on all the Trail Making subscales indicates better performance. The intervention group performed lower than the normative scaled scores on all sub-scales including Condition 1 (4.78 points), Condition 2 (4.05 points), Condition 3 (5 points), Condition 4 (4.21 points), Condition 5 (3.33 points) and Condition 4 All Errors (1.95 points). The control group performed lower than the normative data on all sub-scales including Condition 1 (3.92 points), Condition 2 (4 points), Condition 3 (3.69 points), Condition 4 (4.85 points), Condition 5 (3.31 points) and Condition 4 All Errors (1.23 points), see Table 4.13 and Fig.

4.13. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.14.

Table 4.13 *Trail Making Test Baseline vs Normative Data*

	Intervention (Baseline)	**Control (Baseline)**	**Normative Data**
Condition 1 Scaled Score	*M* 5.22 (*N*=18)	*M* 6.08 (*N*=13)	10
Condition 2 Scaled Score	*M* 5.95 (*N*=19)	*M* 6 (*N*=13)	10
Condition 3 Scaled Score	*M* 5 (*N*=19)	*M* 6.31 (*N*=13)	10
Condition 4 Scaled Score	*M* 5.79 (*N*=19)	*M* 5.15 (*N*=13)	10
Condition 5 Scaled Score	*M* 6.67 (*N*=18)	*M* 6.69 (*N*=13)	10
Condition 4 All Errors (Scaled)	*M* 8.05 (*N*=19)	*M* 8.77 (*N*=13)	10

4.14 *Trail Making Test Baseline vs Normative Data (Frequencies)*

	Intervention (Baseline)			Control (Baseline)		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
C 1 Scaled Int *N*=18 Ctl *N* = 13	13	4	2	10	1	2
C2 Scaled Int *N*=19 Ctl *N* = 13	14	0	5	9	2	2
C3 Scaled Int *N*=19 Ctl *N* = 13	14	1	4	9	1	3
C4 Scaled Int *N*=19 Ctl *N* = 13	13	3	3	10	3	0
C5 Scaled Int *N*=18 Ctl *N* = 13	12	1	5	10	1	3
C4 All Errors Sc Int *N*=19 Ctl *N* = 13	7	4	8	5	2	6

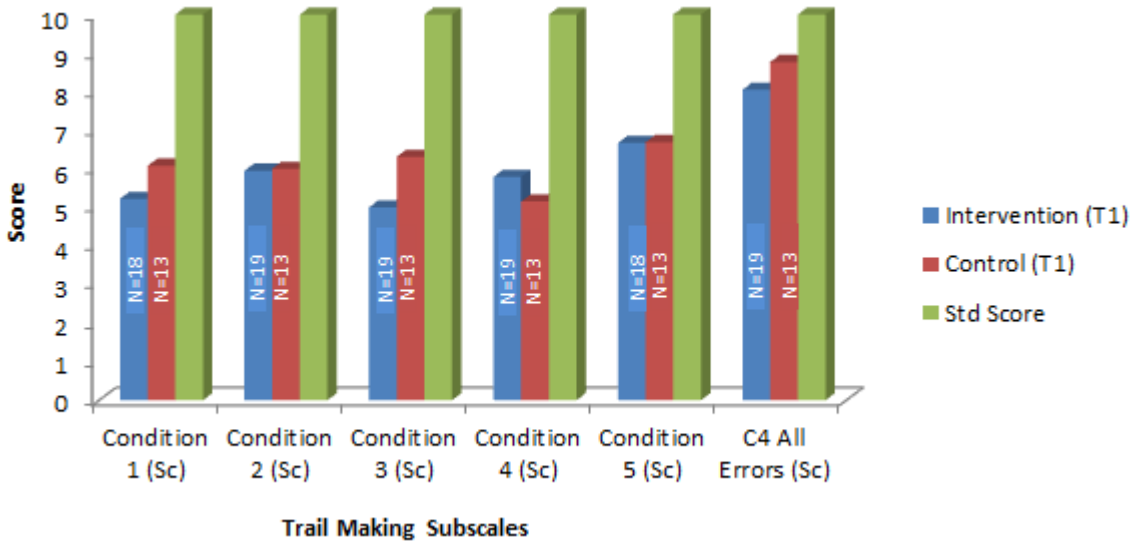


Fig. 4.13 *Trail-Making Test Scaled Scores (Baseline v Normative data)*

4.6 Trail Making Test: Between Group Comparison at T1

4.6.1. Between Group Comparison at T1 (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Condition 1 Scaled Score T1 [*U*=-.34, *p*=.74], Condition 2 Scaled Score T1 [*U*=-.06, *p*=.95], Condition 3 Scaled Score T1 [*U*=-.77, *p*=.44], Condition 4 Scaled Score T1 [*U*=-.50, *p*=.62], Condition 5 Scaled Score T1 [*U*=.00, *p*=1] or Condition 4 All Errors Scaled Score T1 [*U*=-.36, *p*=.72] (see Table 4.15).

Table 4.15 *Trail Making Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Intervention (Baseline)	**Control (Baseline)**	***U***	***p***
Condition 1 Scaled Score	*M* 5.42 (*N*=18)	*M* 6.08 (*N*=13)	-.34	.74
Condition 2 Scaled Score	*M* 5.95 (*N*=19)	*M* 6 (*N*=13)	-.06	.95
Condition 3 Scaled Score	*M* 5 (*N*=19)	*M* 6.31 (*N*=13)	-.77	.44
Condition 4 Scaled Score	*M* 5.79 (*N*=19)	*M* 5.15 (*N*=13)	-.50	.62
Condition 5 Scaled Score	*M* 6.67 (*N*=18)	*M* 6.69 (*N*=13)	.00	1
Condition 4 All Errors (Scaled)	*M* 8.05 (*N*=19)	*M* 8.77 (*N*=13)	-.36	.72

* p<0.05 ** p<0.01

4.7 Sustained Attention Response Task (SART) Between Group Comparison at T1

There was no normative data available for the Sustained Attention Response Task and therefore comparisons could not be made with baseline data for both groups. Higher scores on Total Accuracy and lower scores on Errors of Omission and Errors of Commission

indicates better perfromance on this test. Lower Target Reaction Time scores indicates a faster response to target stimuli and therefore better performance. Lower Reaction Time Error of Commission scores indicates a faster response to clicking the mouse on '3' and therefore poorer performance.

4.7.1. Between Group Comparison at T1 (Mann-Whitney U Test)

A Mann-Whitney U test showed no significant difference between the intervention and control groups on Total Accuracy T1 [*U*=-.49, *p*=.63], Error of Omission T1 [*U*=-.12, *p*=.90], Error of Commission T1 [*U*=-1.14, *p*=.26], Target Reaction Time T1 [*U*=-.32, *p*=.75] or Reaction Time Error of Commission T1 [*U*=-.89, *p*=.37]. See Table 4.18.

There were outliers in the control group (reference no. 18) on Total Accuracy and Error of Omission scores at T1, with this person performing very poorly on these measures when compared to the other participants in their group. There was also an outlier in the intervention group (reference no. 9) on Error of Omission scores at T1, with this person performing very poorly on this measures at T1 when compared to the other participants in their group. Following removal of these cases from the data, a Mann-Whitney U test revealed no significant differences between the groups on Total Accuracy [*U*=-.27, *p*=.81] or Error of Omission scores [*U*=.05, *p*=.98] at T1.

Table 4.16 *Sustained Attention Response Task (SART) Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Int (T1) ***N*=19**	**Control (T1)** ***N*=12**	***U***	***p***
Total Accuracy	*M* 200.05 *SD* 14.83	*M* 184.67 *SD* 47.68	-.49	.63
Error of Omission	*M* 14.79 *SD* 13.39	*M* 28 *SD* 44.39	-.12	.90
Error of Commission	*M* 10.16 *SD* 5.44	*M* 12.33 *SD* 6.12	-1.14	.26
Target Reaction Time	*M* 420.16 *SD* 85.34	*M* 416.77 *SD* 95.72	-.32	.75
Reaction Time Error of Commission	*M* 195.66 *SD* 104.6	*M* 228.75 *SD* 92.55	-.89	.37

* p<0.05 ** p<0.01

4.8 Digit Span Test: Baseline Comparison with Normative Data and Between Group Comparison (By Age Group) at T1

Baseline (T1) mean Digit Span Scaled scores for both groups were compared with normative data obtained from the WAIS-IV Administration and Scoring Manual. Higher scores on Digit Span (scaled) scores indicates more numbers recalled and therefore better performance. In order to make comparisons with the normative data, the two groups (intervention and control) were divided by age group. Between group differences were examined for the 45-54 age group using t-tests (the other age categories had only one participant in one of the groups and so between group differences could not be examined). Between group differences were examined for all age groups using Mann-Whitney U tests.

4.8.1. Baseline vs Normative Data: Age Group 20-24

In the 20-24 years age group, the intervention group scored lower than the normative data (1 point) and the control group also scored lower than the normative data (2 points) on this measure (see Table 4.17 and Fig. 4.14). Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.18.

Table 4.17 *Digit Span Test Baseline vs Normative Data: Age Group 20-24*

	Intervention (Baseline) *N*=1	**Control (Baseline) *N*=2**	**Normative data**
Total Digit Span Scaled	9	*M* 8	10

4.18 *Trail Making Test Baseline vs Normative Data (Frequencies): Age Group 20-24*

	Intervention (Baseline) *N*=1			**Control (Baseline) *N*=2**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span Scaled	1	0	0	2	0	0

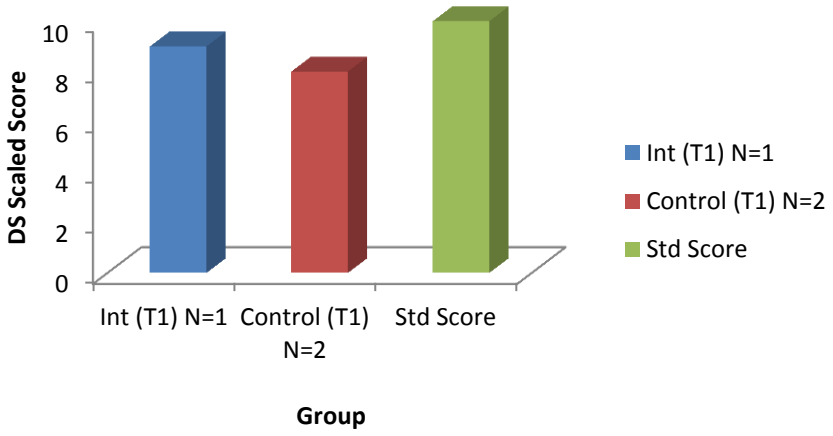


Fig. 4.14 *Digit Span Scaled Scores (Baseline v Normative Data) Age Group 20-24*

4.8.2. Baseline vs Normative Data: Age Group 25-29

In the 25-29 years age group, the intervention group scored lower than the normative data (1 point) and the control group also scored lower than the normative data (3 points) on this measure (see Table 4.19 and Fig. 4.15). Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.20.

Table 4.19 *Digit Span Test Baseline vs Normative data: Age Group 25-29*

	Intervention (Baseline) *N*=1	**Control (Baseline) *N*=3**	**Normative data**
Total Digit Span Scaled	9	*M* 7	10

4.20 *Trail Making Test Baseline vs Normative Data (Frequencies): Age Group 25-29*

	Intervention (Baseline) *N*=1			**Control (Baseline) *N*=3**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span Scaled	1	0	0	2	0	1

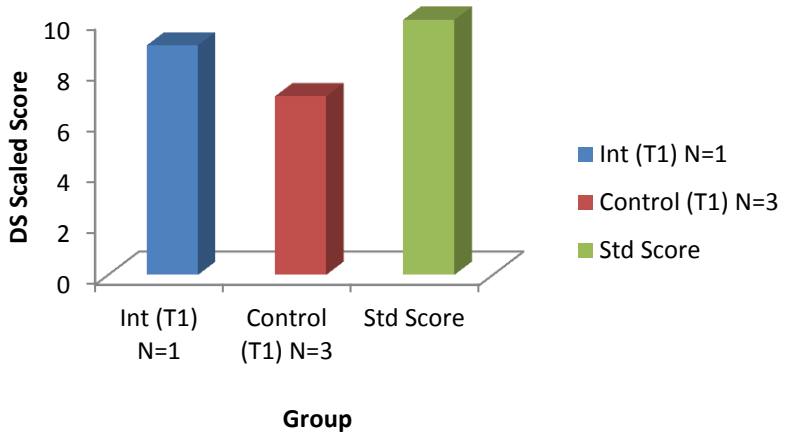


Fig. 4.15 *Digit Span Scaled Scores (Baseline v Normative data) Age Group 25-29*

4.8.3. Baseline vs Normative Data: Age Group 30-34

In the 30-34 years age group, the intervention group scored higher than the normative data (0.5 points) and the control group scored the same as the normative data on this measure (see Table 4.21 and Fig. 4.16). Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.22.

Table 4.21 *Digit Span Test Baseline vs Normative Data: Age Group 30-34*

	Intervention (Baseline) *N*=4	**Control (Baseline) *N*=1**	**Normative data**
Total Digit Span Scaled	*M* 10.5	10	10

4.22 *Trail Making Test Baseline vs Normative Data (Frequencies): Age Group 30-34*

	Intervention (Baseline) *N*=4			**Control (Baseline) *N*=1**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span Scaled	1	1	2	0	1	0

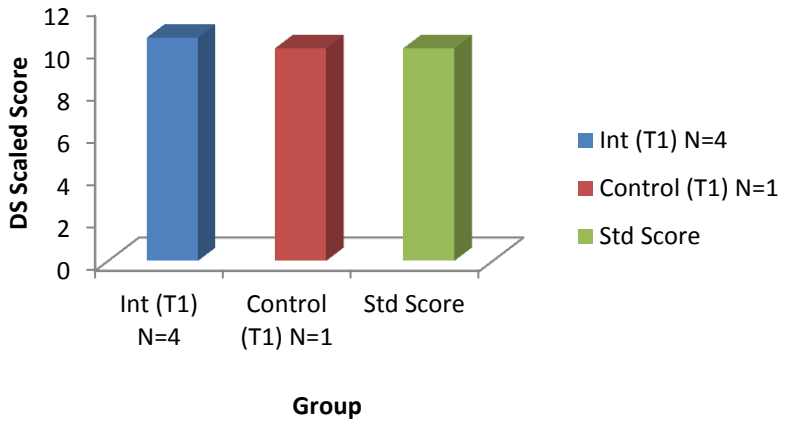


Fig. 4.16 *Digit Span Scaled Scores (Baseline v Normative data) Age Group 30-34*

4.8.4. Baseline vs Normative Data: Age Group 35-44

In the 35-44 years age group, the intervention group scored lower than the normative data (4.5 points) and the control group scored higher than the normative data (1 point) on this measure (see Table 4.23 and Fig. 4.17). Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.24.

Table 4.23 *Digit Span Test Baseline vs Normative Data: Age Group 35-44*

	Intervention (Baseline) *N*=4	**Control (Baseline) *N*=1**	**Normative data**
Total Digit Span Scaled	*M* 5.5	11	10

4.24 *Trail Making Test Baseline vs Normative Data (Frequencies): Age Group 35-44*

	Intervention (Baseline) *N*=4			**Control (Baseline) *N*=1**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span Scaled	4	0	0	0	0	1

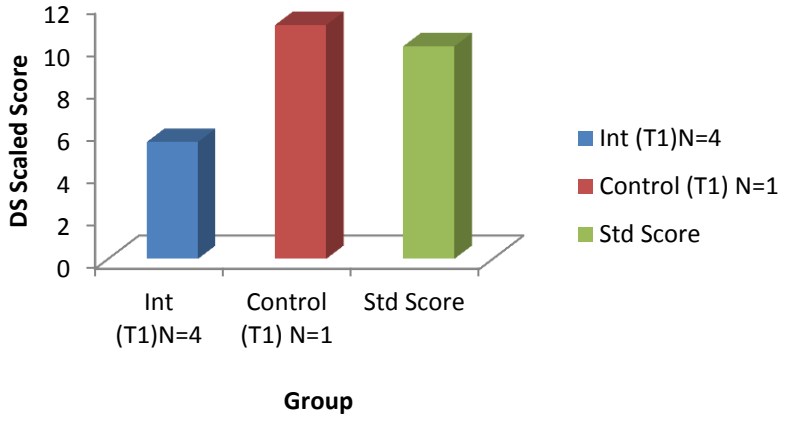


Fig. 4.17 *Digit Span Scaled Scores (Baseline v Normative Data) Age Group 35-44*

4.8.5. Baseline vs Normative Data: Age Group 45-54

In the 45-54 years age group, the intervention group scored lower than the normative data (2.33 points) and the control group also scored lower than the normative data (1.67 points) on this measure (see Table 4.25 and Fig. 4.18). An independent samples t-test revealed no significant difference between the two groups on baseline Total Digit Span scaled scores [$t(4) = -.54$, $p=.62$, 2-tailed]. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.26.

Table 4.25 *Digit Span Test Baseline vs Normative Data: Age Group 45-54*

	Intervention (Baseline) *N*=3	**Control (Baseline) *N*=3**	**Normative data**	***t***	***p***
Total Digit Span Scaled	*M* 7.67	*M* 8.33	10	-.54	.62

4.26 *Trail Making Test Baseline vs Normative Data (Frequencies): Age Group 45-54*

	Intervention (Baseline) *N*=3			**Control (Baseline) *N*=3**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span Scaled	2	1	0	3	0	0

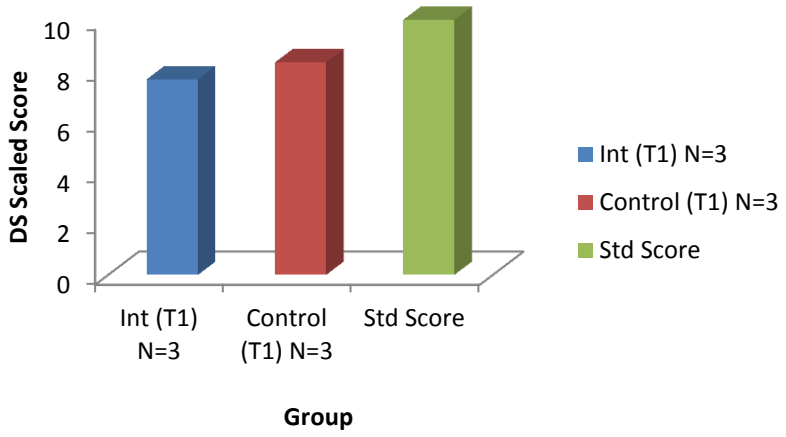


Fig. 4.18 *Digit Span Scaled Scores (Baseline v Normative Data) Age Group 45-54*

4.8.6. Baseline vs Normative Data: Age Group 55-64

In the 55-64 years age group, the intervention group scored higher than the normative data (1.33 points) and the control group scored lower than the normative data (3 points) on this measure (see Table 4.27 and Fig. 4.19). Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.28.

Table 4.27 *Digit Span Test Baseline vs Normative Data: Age Group 55-64*

	Intervention (Baseline) *N*=6	**Control (Baseline) *N*=1**	**Normative data**
Total Digit Span Scaled	*M* 11.33	7	10

4.28 *Trail Making Test Baseline vs Normative Data (Frequencies): Age Group 55-64*

	Intervention (Baseline) *N*=6			**Control (Baseline) *N*=1**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span Scaled	3	0	3	1	0	0

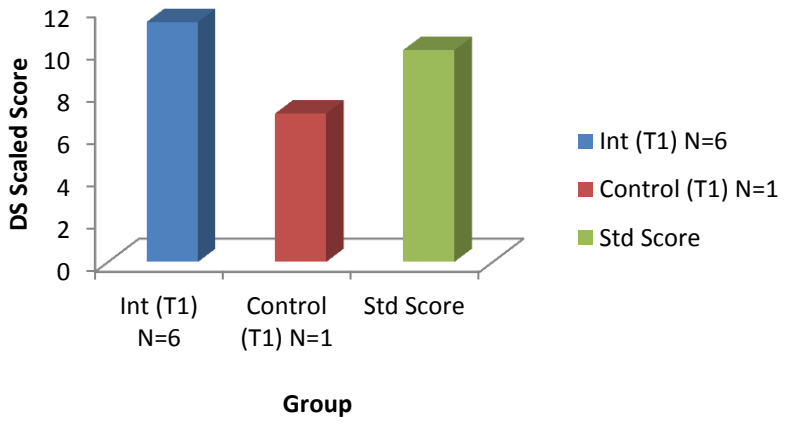


Fig. 4.19 *Digit Span Scaled Scores (Baseline v Normative Data) Age Group 55-64*

4.29 *Digit Span Test Baseline vs Normative Data (Frequencies): All Age Groups*

	Intervention (Baseline) N=19			**Control (Baseline) N=13**		
	Performance < Norm	At Norm Level	Performance > Norm	Performance < Norm	At Norm Level	Performance > Norm
Total Digit Span (Scaled)	12	2	5	9	2	2

4.8.7. Between Group Comparison at T1: All Age Groups (Mann-Whitney U Tests)

A Mann-Whitney U test showed no significant difference between the intervention and control groups on Digit Span Forwards T1 [*U*=-1.62, *p*=.11], Digit Span Backwards T1 [*U*=-.12, *p*=.91], Digit Span Sequencing T1 [*U*=-.45, *p*=.66], Long Digit Span Forwards T1 [*U*=-1.88, *p*=.06], Long Digit Span Backwards T1 [*U*=-.10, *p*=.92], Long Digit Span Sequencing T1 [*U*=-.80, *p*=.43] or Total Digit Span Scaled T1[*U*=-.17, *p*=.86] (see Table 4.30).

Table 4.30 *Digit Span Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Timepoint 1			
	Int ***N*=19**	**Control** ***N*=13**	***U***	***p***
Digit Span Forwards	*M* 10.32 *SD* 3.07	*M* 9 *SD* 1.53	-1.70	.09
Digit Span Backwards	*M* 8.11 *SD* 3.13	*M* 7.54 *SD* 1.90	-1.5	.14
Digit Span Sequencing	*M* 7.26 *SD* 3.07	*M* 8 *SD*2	-.79	.43
Long Digit Span Forwards	*M* 6.74 *SD* 1.76	*M* 5.77 *SD* .93	-1.83	.07
Long Digit Span Backwards	*M* 4.42 *SD* 1.68	*M* 4.23 *SD* 1.09	-1.6	.11
Long Digit Span Sequencing	*M* 5.16 *SD* 1.80	*M* 5.77 *SD* 1.01	-.87	.39
Total Digit Span (Scaled)	*M* 9.11 *SD* 3.91	*M* 8.23 *SD* 2.24	-157	.12

* p<0.05 ** p<0.01

4.9 Hospital Anxiety and Depression Scale: Baseline Comparison with Normative Data and Between Group Comparison (By Age Group) at T1

4.9.1 Baseline vs Normative Data

Baseline (T1) mean HADS scores for both groups were compared with normative HADS data obtained from Crawford, Henry, Crombie & Taylor (2001). Higher scores on Anxiety, Depression and Total Distress subscales indicates higher levels of distress. The intervention group scored higher than the normative data for anxiety (0.65 points), depression (2.21 points) and distress (2.86 points) and the control group also scored higher than the normative data for anxiety (1.71 points), depression (4.09 points) and distress (5.8 points). See Table 4.31 and Fig. 4.20. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.32.

Table 4.31 *HADS Baseline vs Normative Data*

	Intervention (Baseline) *N*=19	**Control (Baseline) *N*=13**	**Normative data**
Anxiety	*M* 6.79	*M* 7.85	*M* 6.14
Depression	*M* 5.89	*M* 7.77	*M* 3.68
Distress	*M* 12.68	*M* 15.62	*M* 9.82

4.32 *HADS Baseline vs Normative Data (Frequencies)*

	Intervention (Baseline) *N*=19			**Control (Baseline) *N*=13**		
	Score < Norm	At Norm Level	Score > Norm	Score < Norm	At Norm Level	Score > Norm
Anxiety	7	3	9	6	0	7
Depression	7	0	12	2	1	10
Distress	8	0	11	3	0	10

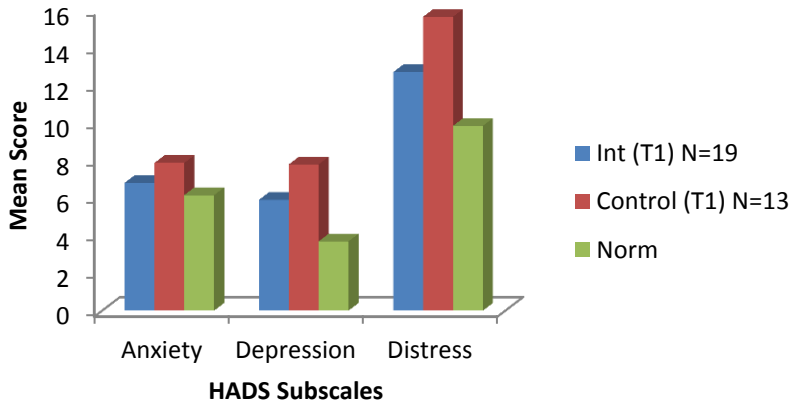


Fig. 4.20 *Hospital Anxiety and Depression Scale (Baseline v Normative Data)*

4.10 Hospital Anxiety and Depression Scale: Between Group Comparison at T1

4.10.1. Between Group Comparison at T1 (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Anxiety T1 [*U*=-.64, *p*=.52], Depression T1 [*U*=-1.27, *p*=.20] or Total Distress T1 [*U*=-1.33, *p*=.19; see Table 4.33].

Table 4.33 *Hospital Anxiety and Depression Scale (HADS) Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Int ***N*=19**	**Control** ***N*=13**	***U***	***p***
Anxiety	*M* 6.79 *SD* 4.26	*M* 7.85 *SD* 4.08	-.64	.52
Depression	*M* 5.89 *SD* 4.07	*M* 7.77 *SD* 3.88	-1.27	.20
Distress	*M* 12.68 *SD* 7.68	*M* 15.62 *SD* 6.10	-1.33	.19

* p<0.05 ** p<0.01

4.10.2. Between Group Comparison at T1: Anxiety and Depression by Category

Anxiety and depression levels for both groups were categorised according to Zigmond & Snaith (1983; see Tables 4.34 and 4.35). In order to investigate group differences using chi-square analysis, participants were further grouped into two categories: (1) normal/mild and (2) moderate/severe. Chi square analysis showed no significant difference between the two groups in relation to anxiety (p = 1, Fisher's Exact Test) or depression (p = 1, Fisher's Exact Test). See Tables 4.36 and 4.37.

Table 4.34 *Anxiety at T1: Results by Category (Frequencies)*

	Timepoint 1	
	Int ***N*=19**	**Control** ***N*=13**
Normal	13	8
Mild	1	2
Moderate	4	3
Severe	1	0

Table 4.35 *Depression at T1: Results by Category (Frequencies)*

	Timepoint 1	
	Int ***N*=19**	**Control** ***N*=13**
Normal	13	5
Mild	2	5
Moderate	4	3
Severe	0	0

Table 4.36 *Anxiety at T1: Chi-Square Analysis*

	Timepoint 1		
	Int ***N*=19**	**Control** ***N*=13**	χ^2 ***(Fisher's Exact Test)***
Normal/Mild	14	10	p=1
Moderate/ Severe	5	3	

Table 4.37 *Depression at T1: Chi-Square Analysis*

	Timepoint 1		
	Int ***N*=19**	**Control** ***N*=13**	χ^2 ***(Fisher's Exact Test)***
Normal/Mild	15	10	p=1
Moderate/ Severe	4	3	

4.11 Satisfaction With Life Scale: Baseline Comparison with Normative Data and Between Group Comparison at T1

4.11.1. Baseline vs Normative Data and Between Group Comparison at T1 (Mann-Whitney U Tests)

Baseline (T1) mean Satisfaction With Life scores for both groups were compared with normative SWLS data obtained from Hinz, Conrad, Schroeter, Glaesmer, Brahler, Zenger, Kocalevent & Herzberg (2018). Higher scores on this measure indicate more satisfaction with life. Both groups scored lower than the normative data for Satisfaction With Life, with the intervention group scoring 6.11 points lower and the control group scoring 9.23 points lower (see Table 4.38 and Fig. 4.21). A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Satisfaction With Life scores at T1 [*U*=-1.07, *p*=.29; see Table 4.38]. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.39.

Table 4.38 *Satisfaction With Life Baseline vs Normative Data and Between Group Comparison at T1 (Mann-Whitney U Test)*

	Intervention (Baseline) *N*=17	**Control (Baseline) *N*=13**	**Normative data**	***U***	***p***
SWL Score	*M* 20.35 *SD* 8.75	*M* 17.23 *SD* 5.93	26.46	-1.07	*.29*

* p<0.05 ** p<0.01

4.39 *Satisfaction With Life Baseline vs Normative Data (Frequencies)*

	Intervention (Baseline) *N*=17			Control (Baseline) *N*=13		
	Score < Norm	At Norm Level	Score > Norm	Score < Norm	At Norm Level	Score > Norm
SWL Score	11	1	5	13	0	0

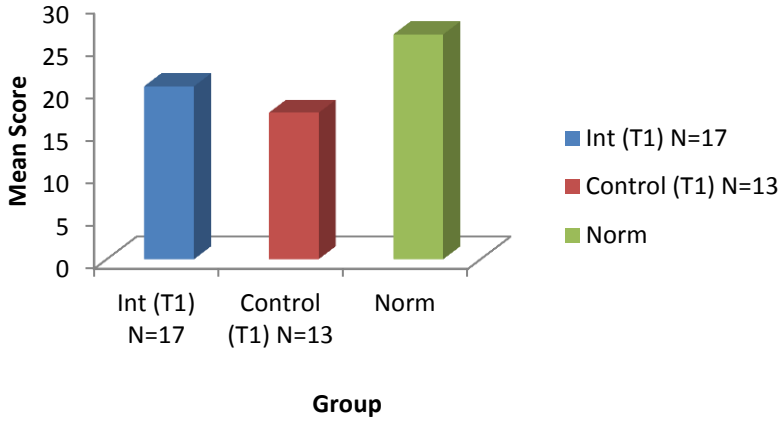


Fig. 4.21 *Satisfaction With Life Scale (Baseline v Normative data)*

4.11.2. Between Group Comparison at T1: Satisfaction With Life by Category

Satisfaction with Life scores were compared between the two groups according to the categories provided in Diener et al. (1985; see Table 4.40).

Table 4.40 *Satisfaction With Life Scale (SWLS) By Category*

	Timepoint 1	
	Int *N*=17	**Control *N*=13**
Extremely Dissatisfied	2	1
Dissatisfied	2	3
Slightly Below Av Satisfied	4	4
Average Satisfied	2	3
Satisfied	5	2
Highly Satisfied	2	0

4.12 Community Integration Questionnaire: Baseline Comparison with Normative Data and Between Group Comparison at T1

Baseline (T1) mean CIQ scores for both groups were compared with normative CIQ data obtained from Callaway, Winkler, Tippett, Migliorini, Herd & Willer (2014). Higher scores on all the subscales and on the total CIQ score indicate better community integration. The intervention group scored lower than the normative data for Home Integration (3.98 points), Social Integration (.07 points), Productivity (1.78 points) and total CIQ (5.83 points), see Table 3.29 and Fig 3.28. The control group scored lower than the normative data for Home Integration (3.04 points), Productivity (2.11 points) and total CIQ (4.62 points) but scored higher than the normative data for Social Integration (0.53 points), see Table 4.41 and Fig. 4.22.

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Home Integration T1 [U=-.41, p=.68], Social Integration T1 [U=-.64, p=.52], Productivity T1 [U=-.47, p=.64] or Total Community Integration T1 [U=-.33, p=.74]. Details of the numbers of participants scoring at normative levels, and those scoring above and below normative levels, are provided in Table 4.42.

Table 4.41 *Community Integration: Baseline vs Normative Data and Between Group Comparison (Mann-Whitney U Test)*

	Intervention (Baseline) *N*=19	**Control (Baseline) *N*=13**	**Normative Data**	***U***	***p***
Home Integration	*M* 3.71 *SD* 2.19	*M* 4.65 *SD* 3.21	*M* 7.69	-.41	.68
Social Integration	*M* 6.63 *SD* 2.45	*M* 7.23 *SD* 2.13	*M* 6.7	-.64	.52
Productivity	*M* 2.95 *SD* 1.93	*M* 2.62 *SD* 1.71	*M* 4.73	-.47	.64
CIQ Score	*M* 13.29 *SD* 5.63	*M* 14.5 *SD* 5.27	*M* 19.12	-.33	.74

* p<0.05 ** p<0.01

4.42 *Community Integration Baseline vs Normative Data (Frequencies)*

	Intervention (Baseline) *N*=19			Control (Baseline) *N*=13		
	Score < Norm	At Norm Level	Score > Norm	Score < Norm	At Norm Level	Score > Norm
Home Integration	19	0	0	10	1	2
Social Integration	9	3	7	6	2	5
Productivity	13	5	1	10	3	0
CIQ Score	17	0	2	10	1	2

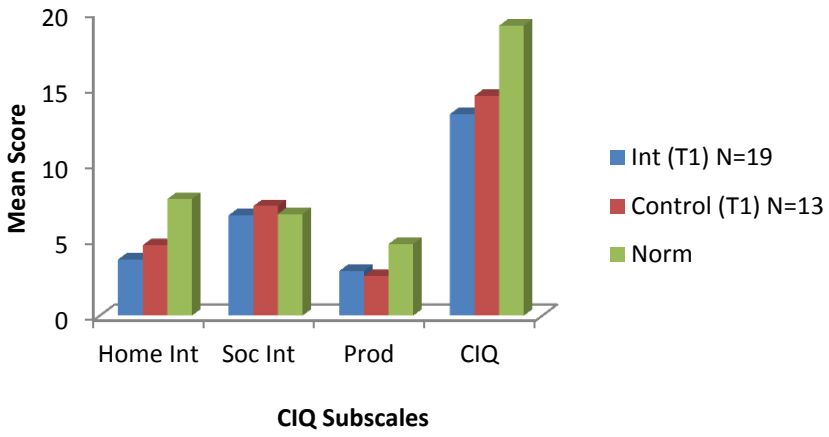


Fig. 4.22 *Community Integration (Baseline v Normative Data)*

4.13 Cognitive Group Self-Evaluation Questionnaire: Between Group Comparison at T1

Higher scores on this measure indicate a more positive rating by a person for their cognitive abilities and how deficits impact on their lives.

4.13.1 Between Group Comparison at T1 (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Cognitive Group Self Evaluation scores at T1 [*U*=-1.49, *p*=.14; see Table 4.43].

Table 4.43 *Cognitive Group Self Evaluation Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Timepoint 1			
	Int ***N*=16**	**Control** ***N*=13**	***U***	***p***
Total CGSE Score	*M* 80.31 *SD* 20.51	*M* 67.92 *SD* 21.74	-1.49	.14

* p<0.05 ** p<0.01

4.14 Knowledege of Brain Injury Questionnaire: Between Group Comparison at T1

Higher scores on this measure indicate a more positive rating by a person for their knowledge of brain injury.

4.14.1 Between Group Comparison at T1 (Mann-Whitney U Tests)

A Mann-Whitney U test showed no significant difference between the intervention and control groups on Knowledge of Brain Injury T1 [*U*=-.28, *p*=.78; see Table 4.44].

Table 4.44 *Knowledge of Brain Injury Results at T1: Between Group Comparison (Mann-Whitney U Test)*

	Timepoint 1			
	Int ***N*=18**	**Control** ***N*=12**	***U***	***p***
Knowledge of Brain Injury	*M* 30.17 *SD* 4.93	*M* 30 *SD* 7.54	-.28	.78

* p<0.05 ** p<0.01

4.15 Summary of Significant Differences between Groups at Baseline

No significant differences were found between the two groups at baseline on any of the dependent variables.

Chapter 5

Pre-post Intervention Effects:
Timepoint 1 versus Timepoint 2

5.1 Data Analysis

Data were screened for normality, skewness, kurtosis and to check for outliers. Within group differences were examined using Wilcoxon Signed Rank Tests. Within groups factor was timepoint (pre-intervention and post-intervention) and dependent measures were the dependent variables for each of the tests and questionnaires used in the study. SPSS version 22 was used for all statistical analyses.

5.2 California Verbal Learning Test: T1 vs T2

On the Total Free Recall subscale, a higher score indicates more words recalled, and therefore better performance. On the intrusions and repetitions subscales, a lower z score indicates better performance due to less intrusions or repetitions being made. On the Learning Slope and Semantic Clustering subscales, a higher z score indicates better performance.

A Wilcoxon Signed Rank Test showed no significant difference between T1 and T2 for the intervention group on Total Free Recall (Z = -1.87, p =.06), Intrusions z score (Z = -1.40, p =.16), Repetitions z score (Z = -1.17, p =.24), Learning Slope z score (Z = -1.48, p =.14) or Semantic Clustering z score (Z = -.66, p =.51), see Table 5.1 and Fig. 5.1.

A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T2 for the control group on Total Free Recall (Z = -1.78, p =.07), Intrusions z score (Z = -.27, p =.79), Repetitions z score (Z = -.49, p =.62), Learning Slope z score (Z = -.57, p =.57) or Semantic Clustering z score (Z = -.07, p =.94), see Table 5.1 and Fig. 5.1.

Table 5.1 *CVLT-II Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int	**Control**	**Int**	**Control**	**Int *Z***	**Int *p***	**Control *Z***	**Control *p***
Total Free Recall	*M* 38.18 *SD*15.82 (*N*=18)	*M* 38 *SD*12.44 (*N*=13)	*M* 40.94 *SD*17.43 (*N*=18)	*M* 43.15 *SD*14.38 (*N*=13)	-1.87	.06	-1.78	.07
Intrusions z score	*M* .41 *SD*1.09 (*N*=17)	*M* .71 *SD*1.03 (*N*=12)	*M* .85 *SD*1.56 (*N*=17)	*M* .88 *SD*1.64 (*N*=12)	-1.40	.16	-.27	.79
Repetitions z score	*M* .41 *SD*1.44 (*N*=17)	*M* .21 *SD*1.18 (*N*=12)	*M* .44 *SD*.88 (*N*=17)	*M* .17 *SD*1.11 (*N*=12)	-1.17	.24	-.49	.62
Learning Slope z score	*M* -.69 *SD* 1.24 (*N*=18)	*M* -1.17 *SD* 1.42 (*N*=12)	*M* -1.25 *SD* 1.32 (*N*=18)	*M* -1.63 *SD* .93 (*N*=12)	-1.48	.14	-.57	.57
Semantic Clustering z score	*M* -.5 *SD* .62 (*N*=18)	*M* -.29 *SD* .40 (*N*=12)	*M* -.44 *SD* .51 (*N*=18)	*M* -.29 *SD* .58 (*N*=12)	-.66	.51	-.07	.94

* p<0.05 ** p<0.01

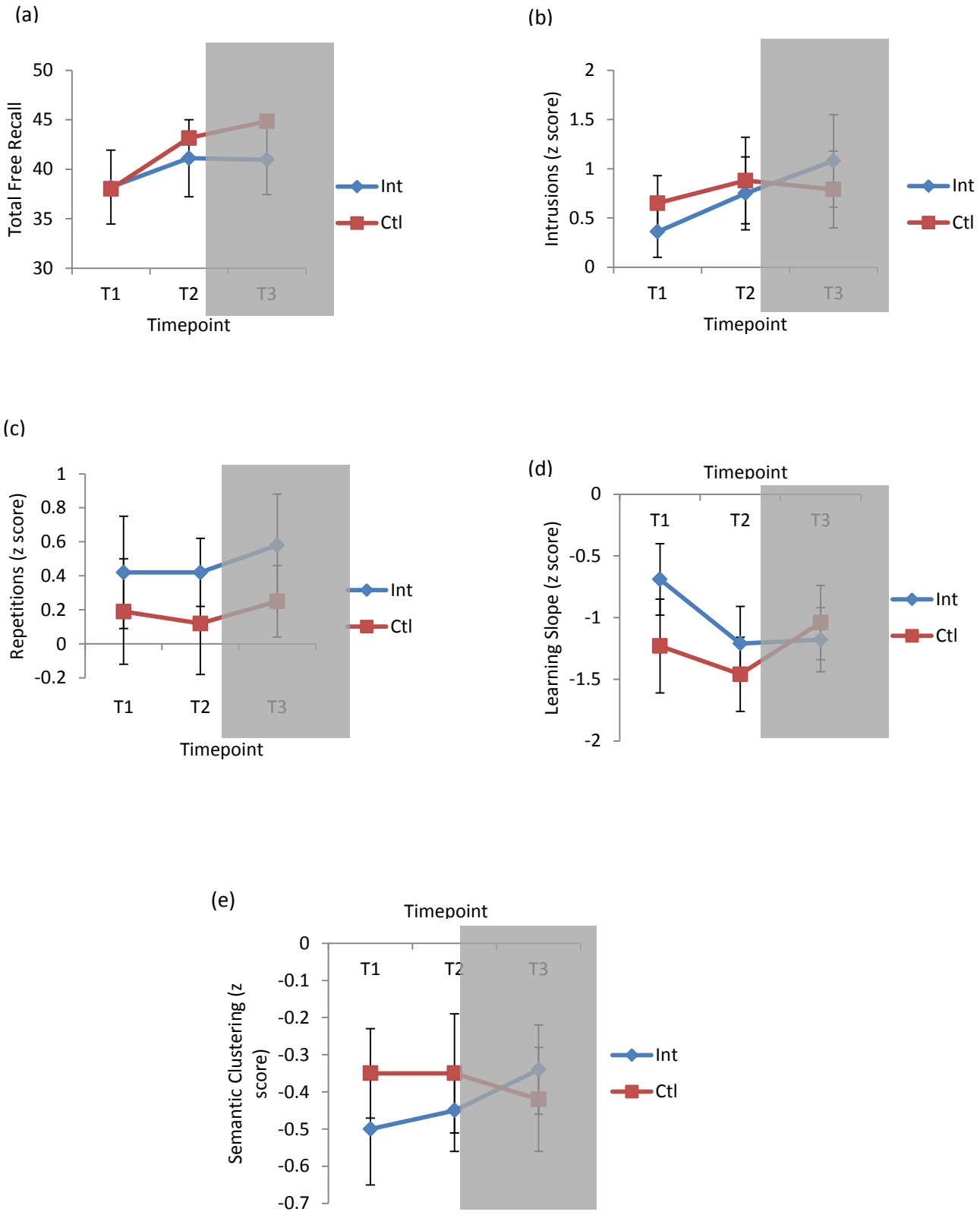


Fig 5.1 *CVLT-II results with (a) Total Free Recall scores; (b) Total Intrusions z score; (c) Total Repetitions z score; (d) Learning Slope z score; and (e) Semantic Clustering z score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.3 Trail Making Test: T1 vs T2

Higher scaled scores on all the Trail Making subscales indicates better performance. A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T2 for the intervention group on Condition 1 Scaled Score (Z = -1.06, p =.29), Condition 2 Scaled Score (Z = -.47, p =.64), Condition 3 Scaled Score (Z = -1.79, p =.07), Condition 4 Scaled Score (Z = -.57, p =.57), Condition 5 Scaled Score (Z = -.73, p =.47) or Condition 4 All Errors Scaleed Score (Z = -.60, p =.55), see Table 5.2 and Fig. 5.2.

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T2 for the control group on Condition 4 Scaled Score (Z = -2.55, p <.05), with the control group showing a significant improvement in performance between T1 and T2 (see Table 5.2 and Fig. 5.2). There was no significant difference between T1 and T2 for the control group on Condition 1 Scaled Score (Z = -1.27, p =.21), Condition 2 Scaled Score (Z = -1.40, p =.16), Condition 3 Scaled Score (Z = .00, p =1), Condition 5 Scaled Score (Z = -.96, p =.34) or Condition 4 All Errors Scaled Score (Z = -1.69, p =.09), see Table 5.2 and Fig. 5.2.

From a clinical perspective, the mean score for the control group on Condition 4 All Errors (scaled score) increased from below normative data levels at T1 (M8.77) to reach normative data levels at T2 (M 10.31). The mean score for the intervention group on this measure increased slightly from T1 (M 8.05) to T2 (M 8.11) but remained below normative data levels at T2. See Table 5.2.

Table 5.2 *Trail Making Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int	**Control**	**Int**	**Control**	**Int *Z***	**Int *p***	**Control *Z***	**Control *p***
Condition 1 (Scaled)	*M* 5.22 *SD*4.24 (*N*=18)	*M* 6.08 *SD*4.46 (*N*=13)	*M* 4.83 *SD*4.11 (*N*=18)	*M* 6.62 *SD*4.19 (*N*=13)	-1.06	.29	-1.27	.21
Condition 2 (Scaled)	*M* 5.95 *SD*3.92 (*N*=19)	*M* 6 *SD*4.20 (*N*=13)	*M* 6.21 *SD*4.34 (*N*=19)	*M* 6.62 *SD*4.03 (*N*=13)	-.47	.64	-1.40	.16
Condition 3 (Scaled)	*M* 5 *SD*4.43 (*N*=19)	*M* 6.31 *SD*4.44 (*N*=13)	*M* 5.95 *SD*4.89 (*N*=19)	*M* 6.31 *SD*4.42 (*N*=13)	-1.79	**.07**	.00	1
Condition 4 (Scaled)	*M* 5.79 *SD*4.60 (*N*=19)	*M* 5.15 *SD*4.20 (*N*=13)	*M* 6.11 *SD*4.63 (*N*=19)	*M* 6.69 *SD*4.50 (*N*=13)	-.57	.57	**-2.55***	**.01***
Condition 5 (Scaled)	*M* 6.67 *SD*4.24 (*N*=18)	*M* 6.69 *SD*4.19 (*N*=13)	*M* 6.83 *SD*4.19 (*N*=18)	*M* 7.23 *SD*3.85 (*N*=13)	-.73	.47	-.96	.34
Condition 4 All Errors (Scaled)	*M* 8.05 *SD*4.71 (*N*=19)	*M* 8.77 *SD*3.92 (*N*=13)	*M* 8.11 *SD*4.47 (*N*=19)	*M* 10.31 *SD* 3.01 (*N*=13)	-.60	.55	-1.69	.09

* p<0.05 ** p<0.01

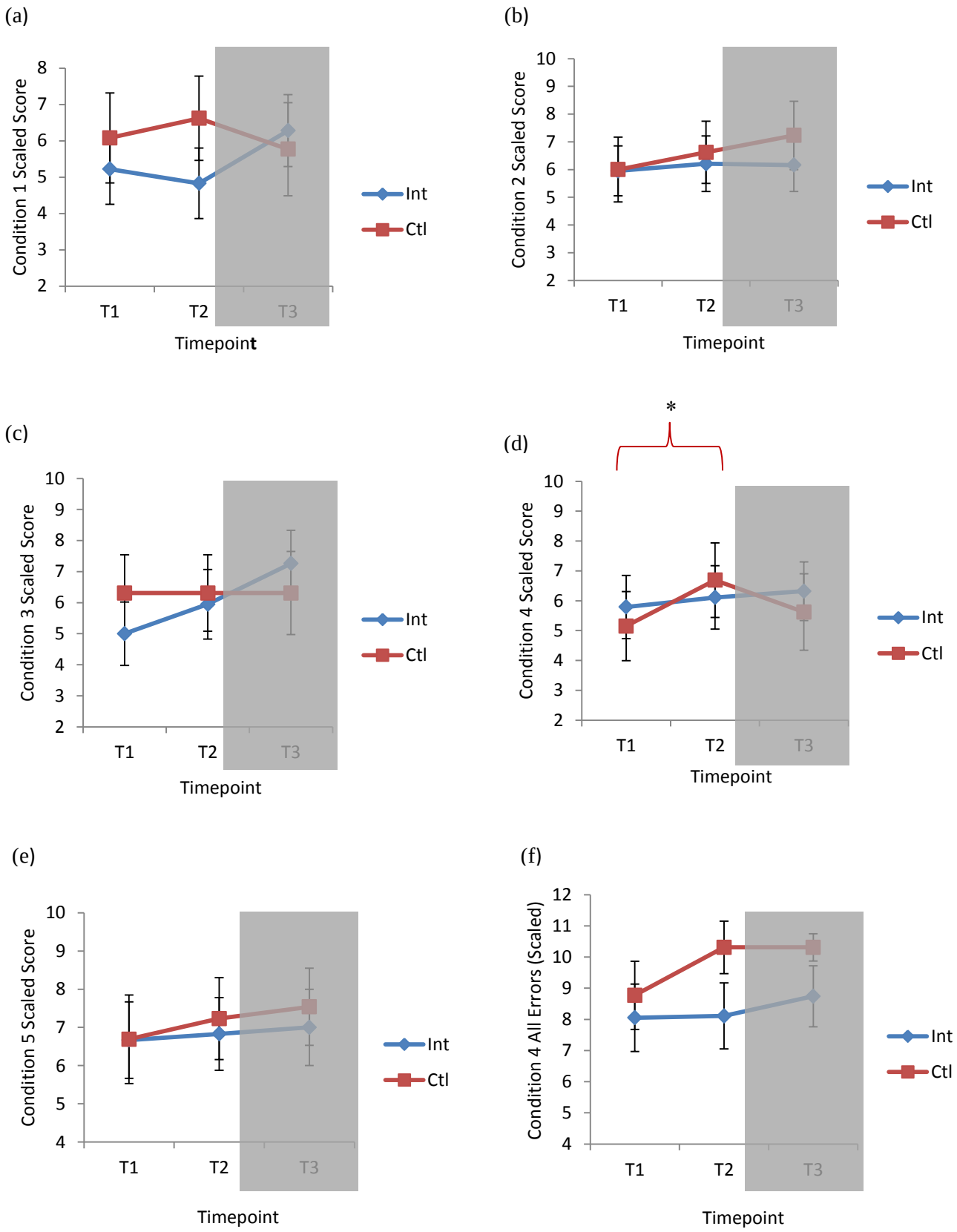


Fig 5.2 *Trail Making Test results with (a) Condition 1 Scaled Score; (b) Condition 2 Scaled Score; (c) Condition 3 Scaled Score; (d) Condition 4 Scaled Score; (e) Condition 5 Scaled Score; and (f) Condition 4 All Errors Scaled Score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.4 Sustained Attention Response Task: T1 vs T2

Higher scores on Total Accuracy and lower scores on Errors of Omission and Errors of Commission indicates better performance on this test. Lower Target Reaction Time scores indicates a faster response to target stimuli and therefore better performance. Lower Reaction Time Error of Commission scores indicates a faster response to clicking the mouse on the number '3' and therefore poorer performance.

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T2 for the intervention group on Error of Commission scores (Z = -2.06, p <.05), with the intervention group showing a significant improvement in performance between T1 and T2 (See Table 5.3 and Fig. 5.3). There was no significant difference between T1 and T2 for the intervention group on Total Accuracy (Z = -1.42, p =.16), Errors of Omission (Z = -.31, p =.76), Target Reaction Time (Z = -.2, p =.85) or Reaction Time Error of Commission scores (Z = -1.42, p =.16), see Table 5.3 and Fig. 5.3.

A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T2 for the control group on Target Reaction Time scores (Z = -2.12, p <.05), with this group showing a significant improvement in target reaction time performance between T1 and T2, reflecting a faster response to target stimuli at T2 (See Table 5.3 and Fig. 5.3). There was no significant difference between T1 and T2 for the control group on Total Accuracy (Z = -.82, p =.41), Errors of Omission (Z = -.62, p =.53), Errors of Commission (Z = -.31, p =.75) or Reaction Time Error of Commission scores (Z = -.63, p =.53), see Table 5.3 and Fig. 5.3.

Table 5.3 *Sustained Attention Response Task (SART) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=12**	**Int** ***N*=19**	**Control** ***N*=12**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Total Accuracy	*M* 200.05 *SD* 14.83	*M* 184.67 *SD* 47.68	*M* 202.79 *SD* 13.15	*M* 195.58 *SD* 25.42	-1.42	.16	-.82	.41
Error of Omission	*M* 14.79 *SD* 13.39	*M* 28 *SD* 44.39	*M* 13.84 *SD* 11.98	*M* 17.50 *SD* 21.8	-.31	.76	-.62	.53
Error of Commission	*M* 10.16 *SD* 5.44	*M* 12.33 *SD* 6.12	*M* 8.26 *SD* 5.30	*M* 11.92 *SD* 6.78	**-2.06***	**.04***	-.31	.75
Target Reaction Time	*M* 420.16 *SD* 85.34	*M* 416.77 *SD* 95.72	*M* 422.56 *SD* 83	*M* 389.06 *SD* 73.03	-.2	.85	**-2.12***	**.03***
Reaction Time Error Commission	*M* 195.66 *SD* 104.6	*M* 228.75 *SD* 92.55	*M* 164.01 *SD* 101.69	*M* 210.92 *SD* 95.50	-1.42	.16	-.63	.53

* p<0.05 ** p<0.01

5.4.1. Variability of Scores between Intervention and Control Groups

The Standard Deviation (*SD*) was much larger for the control group than the intervention group on Total Accuracy and Error of Omission scores at T1 and T2. In order to investigate the distribution of scores on these measures, boxplots were created (see Fig. 5.3-5.6). The boxplots show a larger distribution of scores for the control group on Total Accuracy and Error of Omission scores at T1 and T2. They also show an outlier (reference no. 18) in the control group on Total Accuracy and Error of Omission scores at T1, with this person performing very poorly on these measures at T1, when compared to the other participants in their group. There is an outlier (reference no. 9) in the intervention group on Error of Omission scores at T1, with this person performing very poorly on this measures at T1 when compared to the other participants in their group.

When the outliers (reference no. 9 and 18) were removed from analysis, a Wilcoxon Signed Rank Test found no significant differences on Error of Omission scores (Z = -.06, p =.96) between T1 and T2 for the intervention group and no significant differences on Total

Accuracy (Z = -.4, p =.69) or Error of Omission scores (Z = -.15, p =.88) between T1 and T2 for the control group.

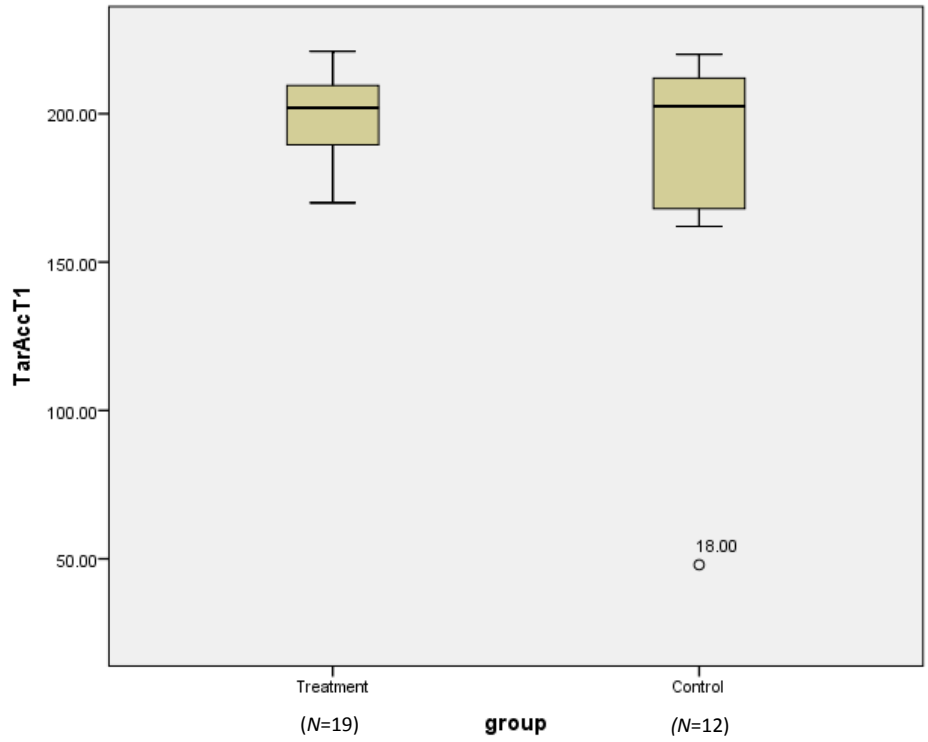


Fig 5.3 *Boxplot showing distribution of Total Accuracy scores for intervention and control groups at T1*

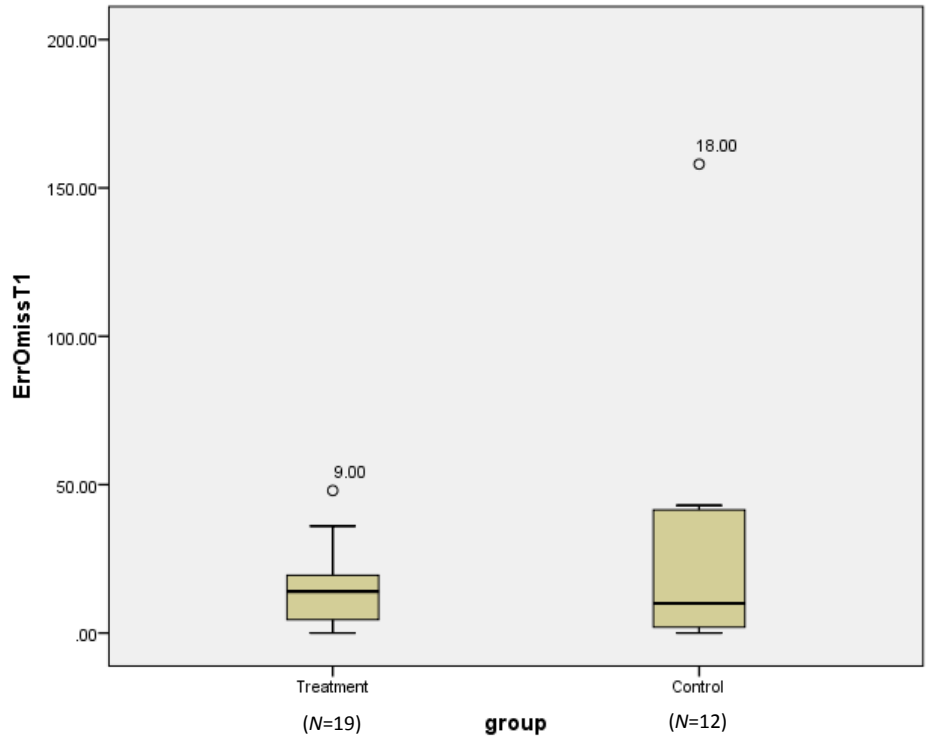


Fig 5.4 *Boxplot showing distribution of Error of Omission scores for intervention and control groups at T1*

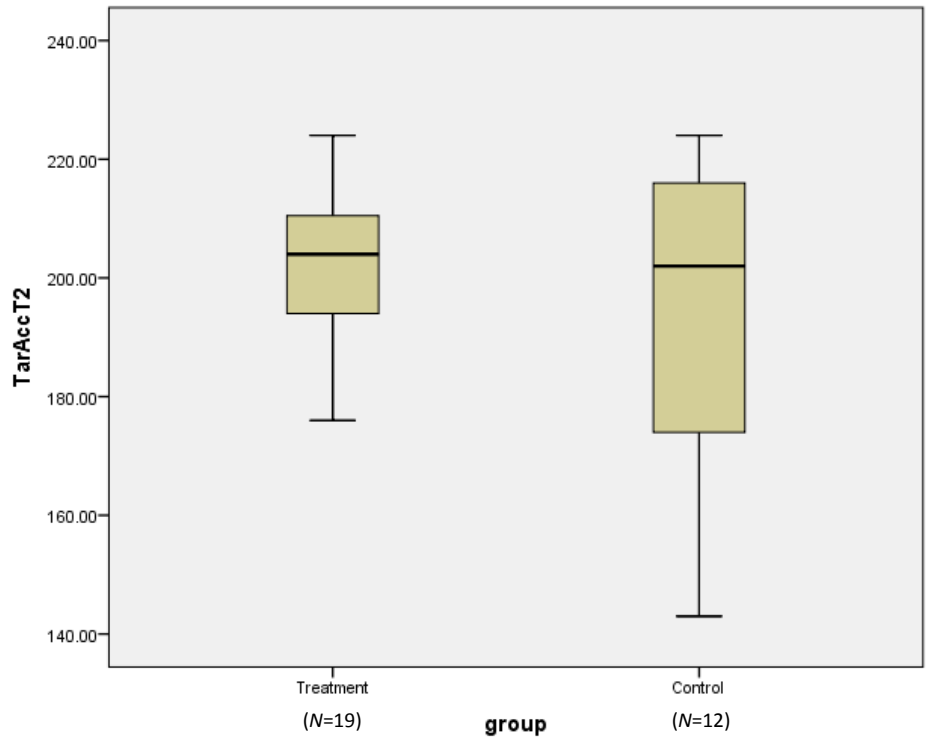


Fig 5.5 *Boxplot showing distribution of Total Accuracy scores for intervention and control groups at T2*

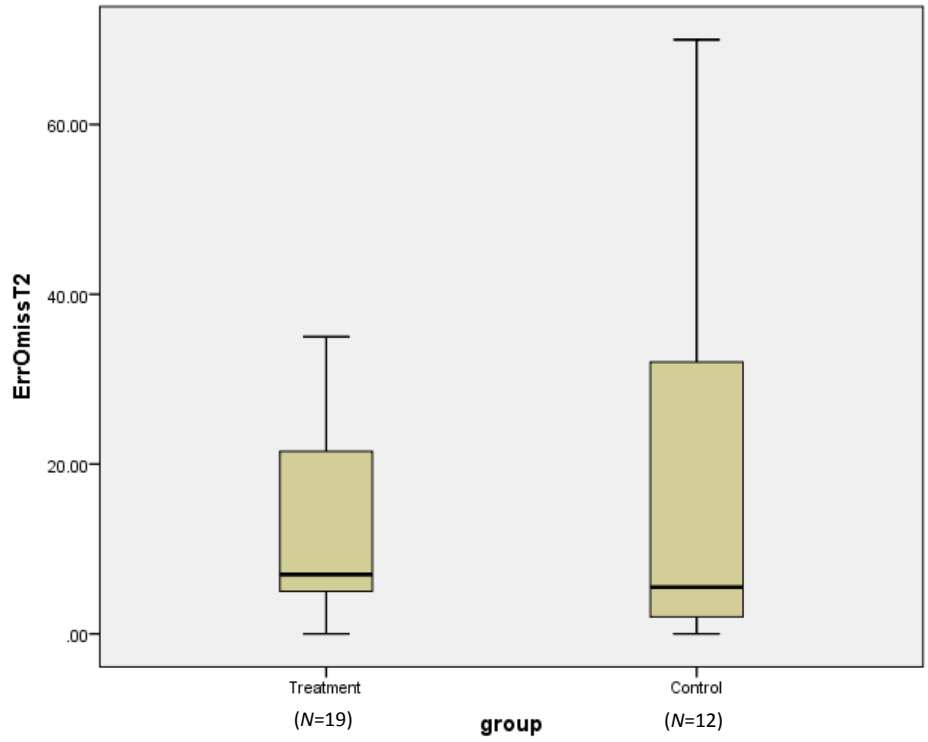


Fig 5.6 *Boxplot showing distribution of Total Accuracy scores for intervention and control groups at T2*

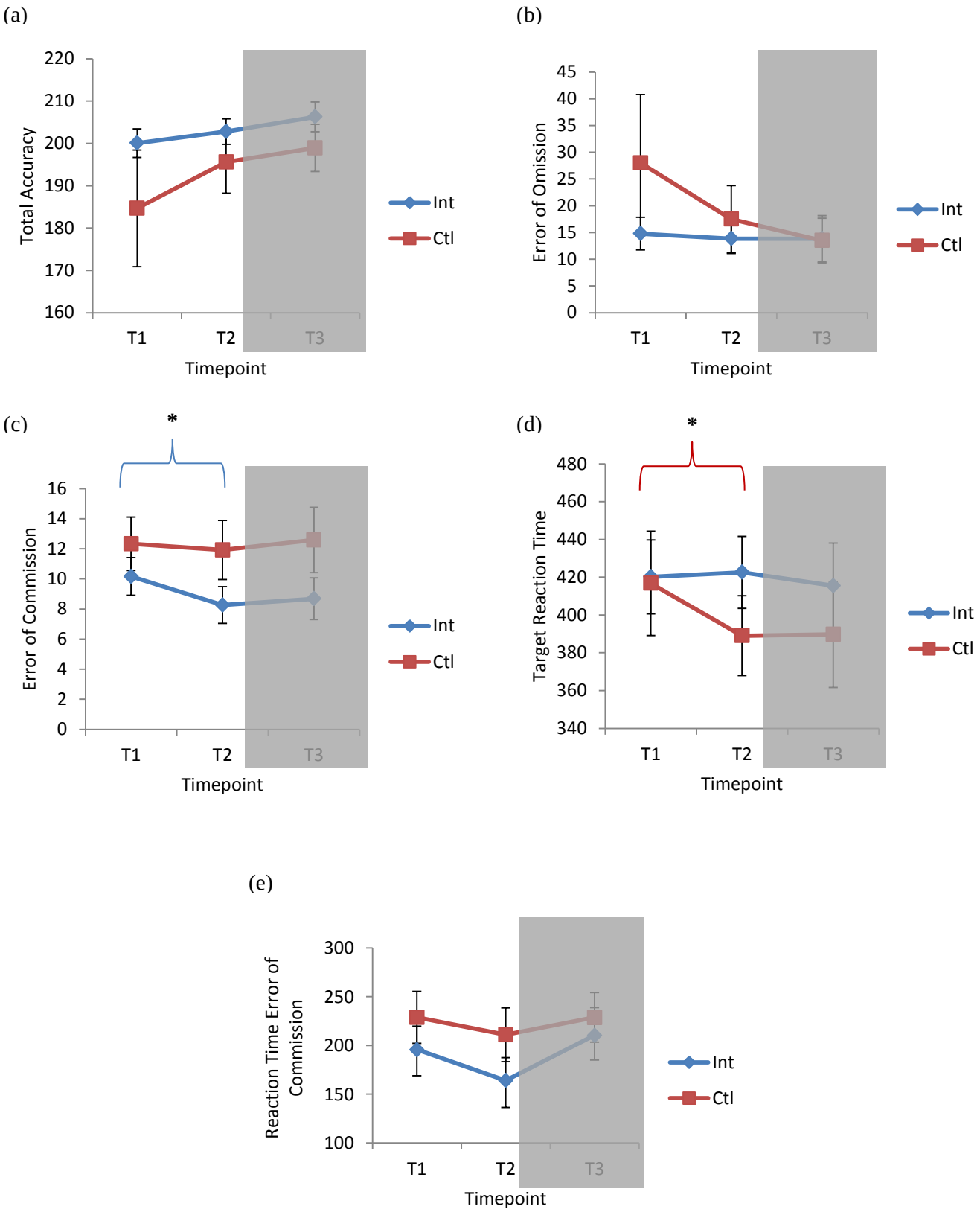


Fig 5.7 *SART Test results with (a) Total Accuracy; (b) Error of Omission; (c) Error of Commission; (d) Target Reaction Time; and (e) Reaction Time Error of Commission for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.5 Digit Span Test: T1 vs T2

Higher scores on all Digit Span subscales indicates more numbers recalled and therefore better performance. A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T2 for the intervention group on Digit Span Sequencing (Z = -2.69, p <.05) and Long Digit Span Sequencing scores (Z = -2.14, p <.05), with the intervention group showing a significant improvement in performance between T1 and T2 (See Table 5.4 and Fig. 5.8). There was no significant difference between T1 and T2 for the intervention group on Digit Span Forwards (Z = -1.83, p =.07), Digit Span Backwards (Z = -.26, p =.79), Long Digit Span Forwards (Z = -1.47, p =.14), Long Digit Span Backwards (Z = -.77, p =.44) or Total Digit Span Scaled (Z = -1.93, p =.05), see Table 5.4 and Fig. 5.8.

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T2 for the control group on Long Digit Span Sequencing scores (Z = -2.16, p <.05), with the control group showing a significant disimprovement in performance between T1 and T2 (See Table 5.4 and Fig. 5.8). There was no significant difference between T1 and T2 for the control group on Digit Span Forwards (Z = -.06, p =.95), Digit Span Backwards (Z = -.75, p =.45), Digit Span Sequencing (Z = -.67, p =.50), Long Digit Span Forwards (Z = -.68, p =.50), Long Digit Span Backwards (Z = -.83, p =.41) or Total Digit Span Scaled (Z = -.80, p =.43), see Table 5.4 and Fig. 5.8.

From a clinical perspective, the mean score for the intervention group on Total Digit Span (scaled) increased from just below normative data levels (10) at T1 (M9.11) to just above normative data levels at T2 (M10.05). The mean score for the control group on this measure decreased slightly from T1 (M 8.23) to T2 (M 8) and remained below normative data levels at T2. See Table 5.4.

Table 5.4 *Digit Span Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control p**
Digit Span Forwards	*M* 10.32 *SD* 3.07	*M* 9 *SD* 1.53	*M* 10.95 *SD*2.78	*M* 9.23 *SD* 2.71	-1.83	.07	-.06	.95
Digit Span Backwards	*M* 8.11 *SD* 3.13	*M* 7.54 *SD* 1.90	*M* 8.16 *SD* 2.46	*M* 7.31 *SD* 1.93	-.26	.79	-.75	.45
Digit Span Sequencing	*M* 7.26 *SD* 3.07	*M* 8 *SD*2	*M* 8.37 *SD* 2.89	*M* 7.54 *SD*2.60	**-2.69***	**.01***	-.67	.50
Long Digit Span Forwards	*M* 6.74 *SD* 1.76	*M* 5.77 *SD* .93	*M* 7.05 *SD* 1.58	*M* 6 *SD* 1.35	-1.47	.14	-.68	.50
Long Digit Span Backwards	*M* 4.42 *SD* 1.68	*M* 4.23 *SD* 1.09	*M* 4.63 *SD* 1.54	*M* 4 *SD* 1.08	-.77	.44	-.83	.41
Long Digit Span Sequencing	*M* 5.16 *SD* 1.80	*M* 5.77 *SD* 1.01	*M* 5.74 *SD* 1.66	*M* 4.92 *SD* 1.32	**-2.14***	**.03***	**-2.16***	**.03***
Total Digit Span (Scaled)	*M* 9.11 *SD* 3.91	*M* 8.23 *SD* 2.24	*M* 10.05 *SD* 3.52	*M* 8 *SD* 3.14	-1.93	.05	-.80	.43

* p<0.05 ** p<0.01

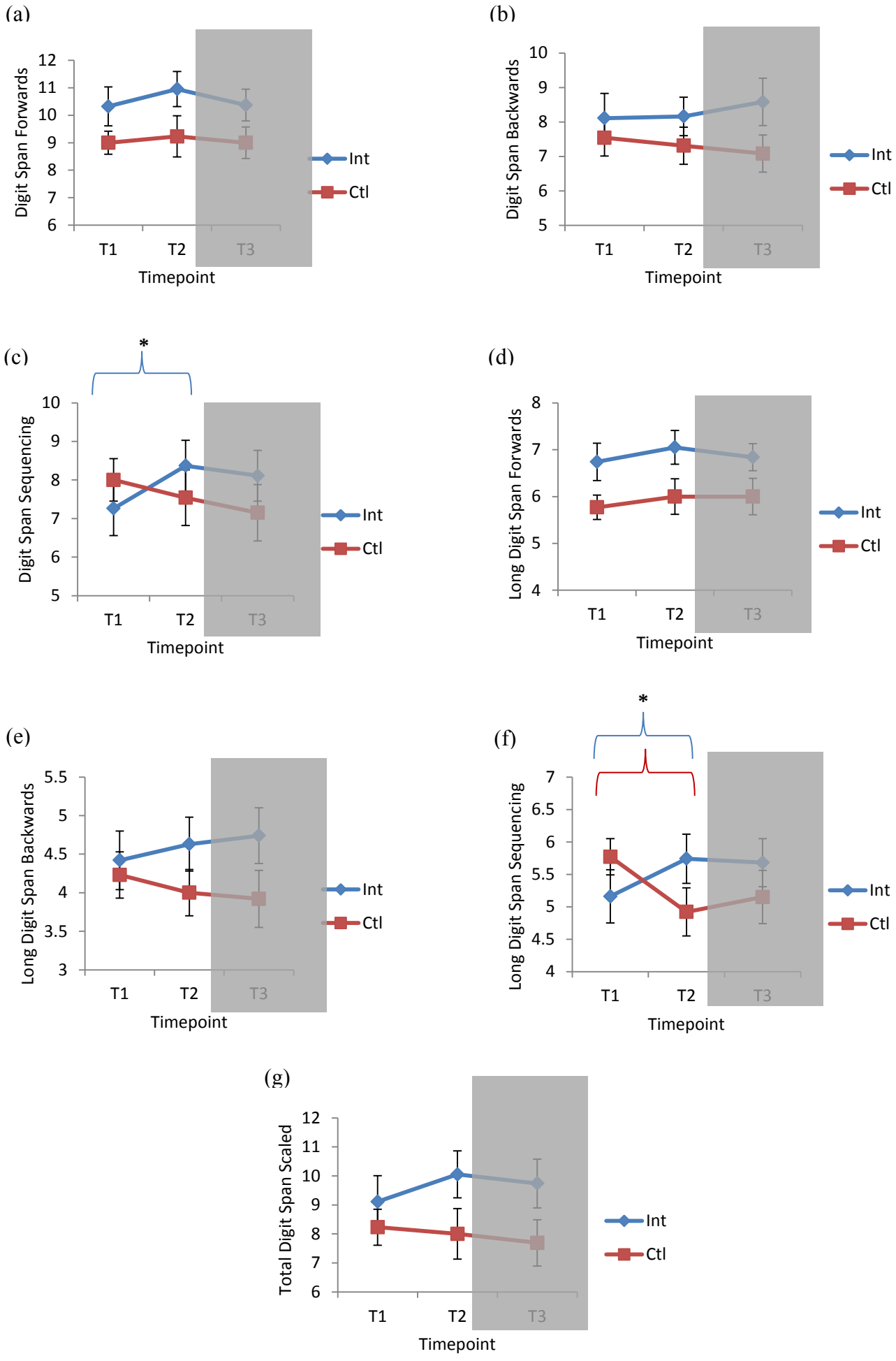


Fig 5.8 *Digit Span results with (a) Digit Span Forwards; (b) Digit Span Backwards; (c) Digit Span Sequencing; (d) Long Digist Span Forwards; (e) Long Digit Span Backwards; (f) Long Digit Span Sequencing; and (g) Total Digit Span Scaled Score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.6 Hospital Anxiety and Depression Scale: T1 vs T2

Higher scores on Anxiety, Depression and Total Distress subscales indicates higher levels of distress. A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T2 for the intervention group on Anxiety (Z = -.71, p =.48), Depression (Z = -.43, p =.67) or Total Distress scores (Z = -1.14, p =.26), see Table 5.5 and Fig. 5.9. There was no significant difference between T1 and T2 for the control group on Anxiety (Z = -.63, p =.53), Depression (Z = -.55, p =.58) or Total Distress scores (Z = -.91, p =.36), see Table 5.5 and Fig. 5.9.

From a clinical perspective, the mean score for the intervention group on Total Distress decreased slightly from T1 (M12.68) to T2 (M12.32), but remained above normative data levels (9.82) at T2. Similarly, the mean score for the control group decreased slightly from T1 (M15.62) to T2 (M14.77) on this measure, but remained above normative data levels (9.82) at T2. See Table 5.5.

Frequencies of participants in the various categories for anxiety and depression (normal, mild, moderate and severe) were compared between T1 and T2 (see Tables 5.6 and 5.7) . For the intervention group, the number of participants in the moderate and severe categories for anxiety reduced from n=5 at T1 to n=4 at T2 and the number of participants in the normal range reduced from n=13 at T1 to n=12 at T2. The number of intervention group participants in the moderate and severe categories for depression reduced from n=4 at T1 to n=2 at T2, although there was one person in the 'severe' category at T2 and none in this category at T1. The number of intervention group participants in the normal range for depression reduced from n=13 at T1 to n=12 at T2.

For the control group, the number of participants in the moderate and severe categories for anxiety stayed the same (n=3) between both timepoints and the number of participants in the normal range reduced from n=8 at T1 to n=7 at T2. The number of control group participants in the moderate and severe categories for depression also stayed the same

(*n*=3) between both timepoints, with 2 participants falling into the 'severe' category at T2 and none in this category at T1. The number of participants in the normal range for depression increased from *n*=5 at T1 to *n*=8 at T2.

Table 5.5 *Hospital Anxiety and Depression Scale (HADS) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Anxiety	*M* 6.79 *SD* 4.26	*M* 7.85 *SD* 4.08	*M* 6.21 *SD* 4.72	*M* 7.38 *SD* 4.19	-.71	.48	-.63	.53
Depression	*M* 5.89 *SD* 4.07	*M* 7.77 *SD* 3.88	*M* 6.11 *SD* 4.43	*M* 7.38 *SD* 4.94	-.43	.67	-.55	.58
Distress	*M* 12.68 *SD* 7.68	*M* 15.62 *SD* 6.10	*M* 12.32 *SD* 8.06	*M* 14.77 *SD* 8.18	-1.14	.26	-.91	.36

* p<0.05 ** p<0.01

Table 5.6 *Anxiety at T1and T2: Results by Category (Frequencies)*

	Timepoint 1		**Timepoint 2**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**
Normal	13	8	12	7
Mild	1	2	3	3
Moderate	4	3	3	3
Severe	1	0	1	0

Table 5.7 *Depression at T1 and T2: Results by Category (Frequencies)*

	Timepoint 1		**Timepoint 2**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**
Normal	13	5	12	8
Mild	2	5	5	2
Moderate	4	3	1	1
Severe	0	0	1	2

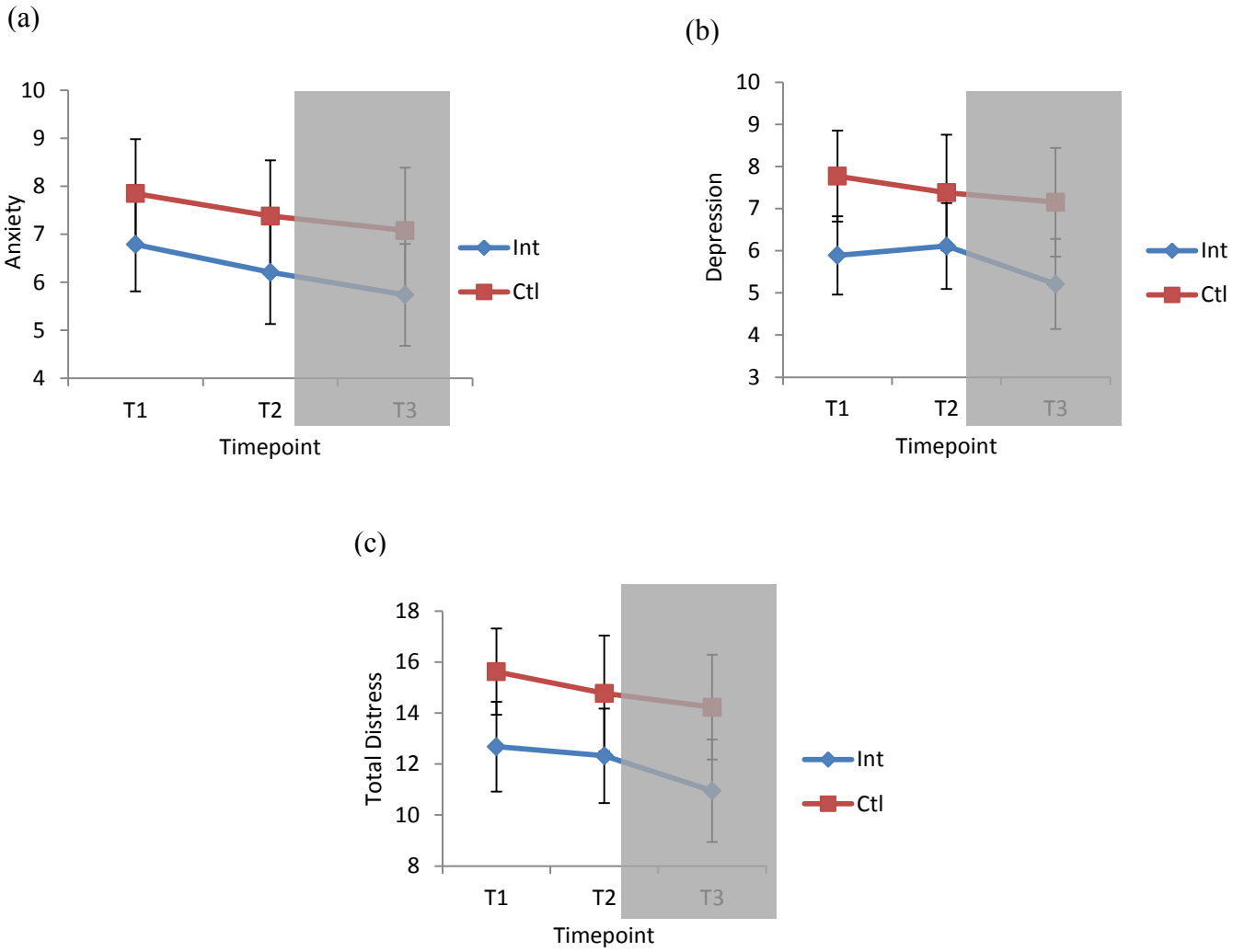


Fig 5.9 *HADS results with (a) Anxiety; (b) Depression; and (c) Distress for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.7 Satisfaction With Life Scale: T1 vs T2

Higher scores on this measure indicate more satisfaction with life. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T2 on Satisfaction With Life scores for the intervention group (Z = -.33, p =.74), or the control group (Z = -1.06, p =.29), see Table 5.8 and Fig. 5.10.

From a clinical perspective, the mean score for the intervention group on Satisfaction With Life increased slightly from T1 (M20.35) to T2 (M20.82), but remained below normative data levels (26.46) at T2. Similarly, the mean score for the control group increased

slightly from T1 (*M*17.23) to T2 (*M*18.77) on this measure, but remained below normative data levels (26.46) at T2. See Table 5.8.

Table 5.8 *Satisfaction With Life Scale (SWLS) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int *N*=17	**Control** *N*=13	**Int** *N*=17	**Control** *N*=13	**Int** *Z*	**Int** *p*	**Control** *Z*	**Control** *p*
Satisfaction With Life	*M* 20.35 *SD* 8.75	*M* 17.23 *SD* 5.93	*M* 20.82 *SD* 8.34	*M* 18.77 *SD* 8.02	-.33	.74	-1.06	.29

* p<0.05 ** p<0.01

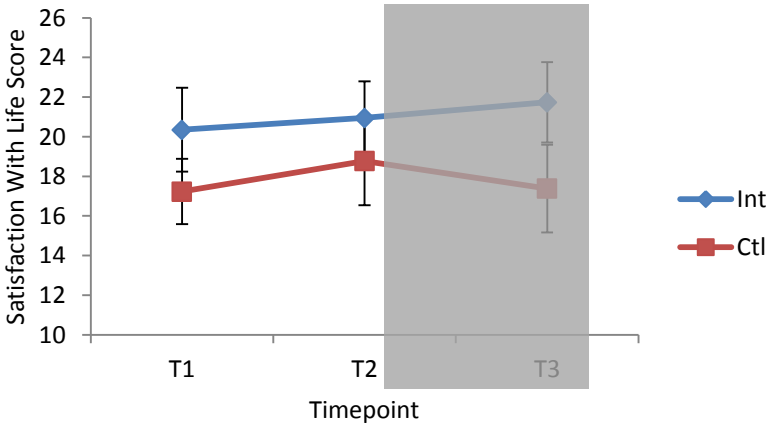


Fig 5.10 *Satisfaction With Life Scale results for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.8 Community Integration Questionnaire: T1 vs T2

Higher scores on all the CIQ subscales and on the total CIQ score indicate better community integration. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T2 for the intervention group on Home Integration (Z = -.08, p =.94), Social Integration (Z = -1.66, p =.10), Productivity (Z = -.98, p =.33) or Total Community Integration (Z = -1.05, p =.30), see Table 5.9 and Fig. 5.11.

A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T2 for the control group on Home Integration (Z = -1.43, p =.15), Social Integration (Z = -.76, p =.45), Productivity (Z = -.75, p =.45) or Total Community Integration (Z = -1.10, p =.27), see Table 5.9 and Fig. 5.11.

From a clinical perspective, the mean score for the intervention group on Total Community Integration increased slightly from T1 (*M*13.29) to T2 (*M*14.13), but remained below normative data levels (19.12) at T2. Similarly, the mean score for the control group increased slightly from T1 (*M*14.5) to T2 (*M*15.77) on this measure, but remained below normative data levels (19.12) at T2. See Table 5.9.

Table 5.9 *Community Integration Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		**Timepoint 2**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Home Integration	*M* 3.71 *SD* 2.19	*M* 4.65 *SD* 3.21	*M* 3.55 *SD* 2.23	*M* 5.23 *SD* 2.97	-.08	.94	-1.43	.15
Social Integration	*M* 6.63 *SD* 2.45	*M* 7.23 *SD* 2.13	*M* 7.21 *SD* 1.75	*M* 7.62 *SD* 3.18	-1.66	.10	-.76	.45
Productivity	*M* 2.95 *SD* 1.93	*M* 2.62 *SD* 1.71	*M* 3.37 *SD* 1.71	*M* 2.85 *SD* 1.72	-.98	.33	-.75	.45
Total CIQ Score	*M* 13.29 *SD* 5.63	*M* 14.5 *SD* 5.27	*M* 14.13 *SD* 4.23	*M* 15.77 *SD* 5.44	-1.05	.30	-1.10	.27

* p<0.05 ** p<0.01

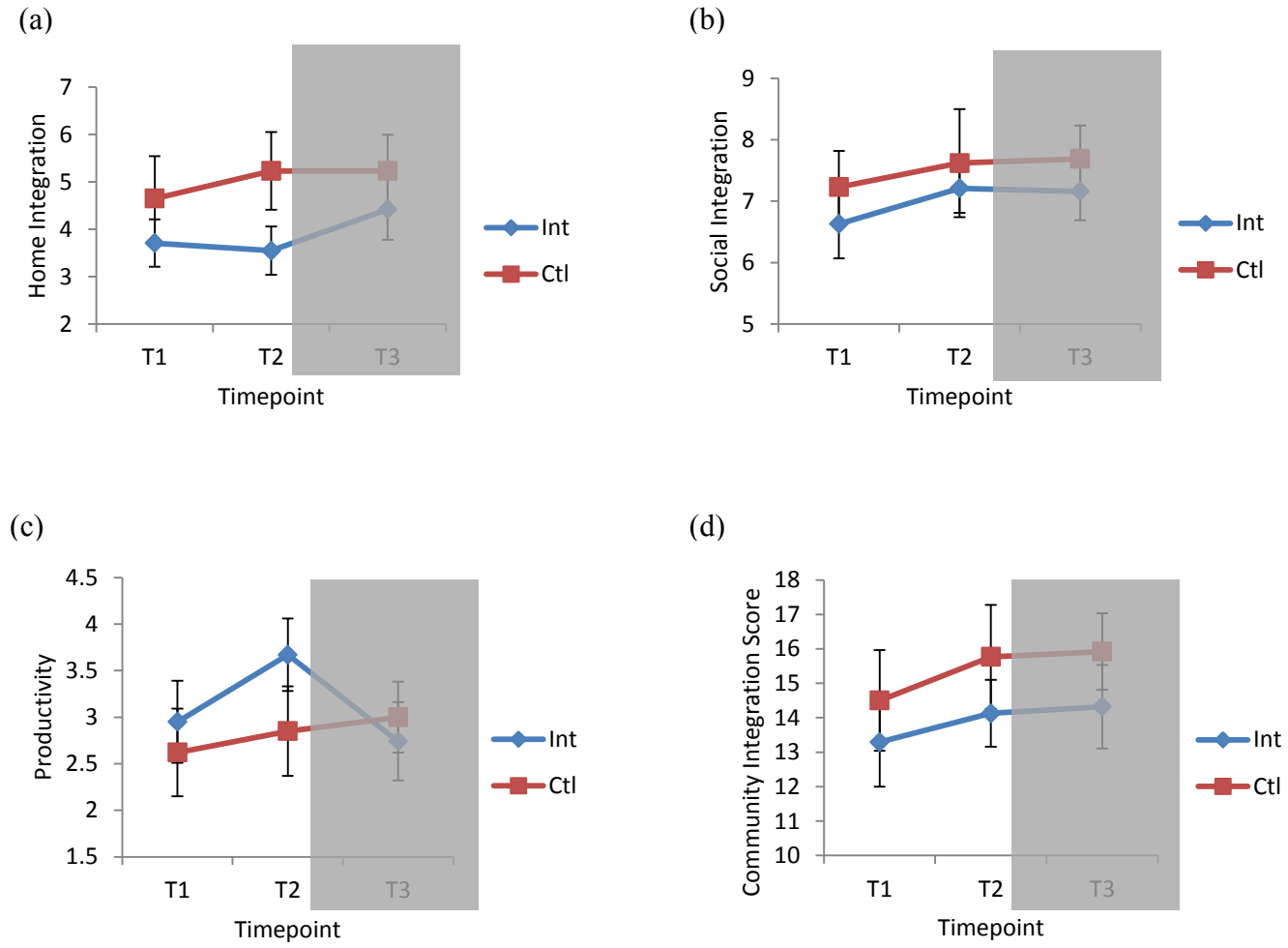


Fig 5.11 *Community Integration Scores with (a) Home Integration; (b) Social Integration; (c) Productivity; and (d) Total CIQ Score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.9 Cognitive Group Self-Evaluation Questionnaire: T1 vs T2

Higher scores on this measure indicate a more positive rating by a person for their cognitive abilities and how deficits impact on their lives. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T2 on Cognitive Group Self Evaluation scores for the intervention group (Z = -.08, p =.94), or the control group (Z = -1.51, p =.13), see Table 5.10 and Fig. 5.12.

Table 5.10 *Cognitive Group Self Evaluation Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		Timepoint 2		Wilcoxon		Wilcoxon	
	Int ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Total CGSE Score	*M* 80.31 *SD* 20.51	*M* 67.92 *SD* 21.74	*M* 78.13 *SD* 16.74	*M* 74.38 *SD* 18.58	-.08	.94	-1.51	.13

* p<0.05 ** p<0.01

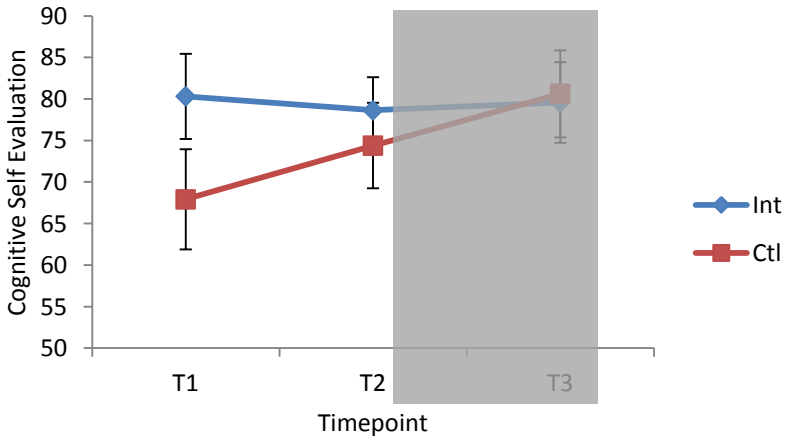


Fig 5.12 *Cognitive Group Self Evaluation Questionnaire Results for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T2*

5.10 Knowledege of Brain Injury Questionnaire: T1 vs T2

Higher scores on this measure indicate a more positive rating by a person for their knowledge of brain injury. A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T2 on Knowledge of Brain Injury scores for the intervention group (Z = -1.69, p =.09), or the control group (Z = -.75, p =.46), see Table 5.11 and Fig. 5.13.

Table 5.11 *Knowledge of Brain Injury Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T2)*

	Timepoint 1		Timepoint 2		Wilcoxon		Wilcoxon	
	Int ***N*=18**	**Control** ***N*=12**	**Int** ***N*=18**	**Control** ***N*=12**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Knowledge of Brain Injury	*M* 30.17 *SD* 4.93	*M* 30 *SD* 7.54	*M* 32.67 *SD* 2.72	*M* 33.17 *SD* 3.79	-1.69	.09	-.75	.46

* p<0.05 ** p<0.01

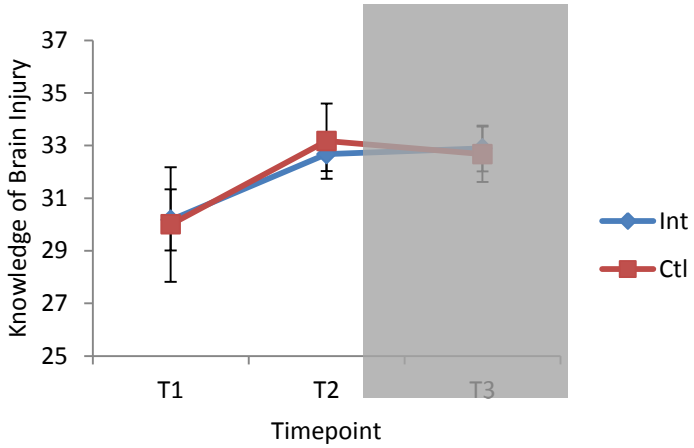


Fig 5.13 *Knowledge of Brain Injury Questionnaire Results for Intervention (Int) and Control (Ctl) groups across timepoints T1 to*

5.11 Summary of Significant Effects T1 vs T2

5.11.1. Signifcant Effects for Intervention Group

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T2 for the intervention group on the Error of Commission subscale of the SART test (Z = -2.06, p <.05), with the intervention group showing a significant improvement in performance between T1 and T2.

On the Digit Span test, a Wilcoxon Signed Rank Test revealed a significant difference between T1 and T2 for the intervention group on Digit Span Sequencing (Z = -2.69, p <.05) and Long Digit Span Sequencing scores (Z = -2.14, p <.05), with participants showing a significant improvement in performance between T1 and T2. From a clinical perspective, the mean score for the intervention group on Total Digit Span (scaled) increased from just below normative data levels (10) at T1 (M9.11) to just above normative data levels at T2 (M10.05).

5.11.2. Signifcant Effects for Control Group

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T2 for the control group on Condition 4 Scaled Score of the Trail Making Test (Z = -2.55, p <.05), with the control group showing a significant improvement in performance between T1 and T2. From a clinical perspective, the mean score for the control group on Condition 4 All Errors (scaled score) increased from below normative data levels at T1 (M8.77) to reach normative data levels at T2 (M 10.31).

A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T2 for the control group on the Target Reaction Time subscale of the SART test (Z = -2.12, p <.05), with participants showing a significant improvement in target reaction time performance between T1 and T2, reflecting a faster response to target stimuli at T2. On the Digit Span test, a Wilcoxon Signed Rank Test showed a significant difference between T1 and T2 for the control group on Long Digit Span Sequencing scores (Z = -2.16, p <.05), with the control group showing a significant disimprovement in performance between T1 and T2.

Chapter 6

Longitudinal Follow-Up:

Timepoint 1 versus Timepoint 3 and

Timepoint 2 versus Timepoint 3

6.1 Data Analysis T1 vs T3

Data were screened for normality, skewness, kurtosis and to check for outliers. Within group differences were examined using Wilcoxon Signed Rank Tests. Within groups factor was timepoint (pre-intervention and 6 months after completion of intervention) and dependent measures were the dependent variables for each of the tests and questionnaires used in the study. SPSS version 22 was used for all statistical analyses.

6.2 California Verbal Learning Test: T1 vs T3

On the Total Free Recall subscale, a higher score indicates more words recalled, and therefore better performance. On the intrusions and repetitions subscales, a lower z score indicates better performance due to less intrusions or repetitions being made. On the Learning Slope and Semantic Clustering subscales, a higher z score indicates better performance.

A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 for the intervention group on Total Free Recall (Z = -1.49, p =.14), Intrusions z score (Z = -1.64, p =.1), Repetitions z score (Z = -1.29, p =.20), Learning Slope z score (Z = -1.58, p =.12) or Semantic Clustering z score (Z = -1.23, p =.22), see Table 6.1 and Fig. 6.1.

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T3 for the control group on Total Free Recall (Z = -2.38, p <.05), with participants performing significantly better at T3 than T1 (see Table 6.1 and Fig. 6.1). No significant difference was seen between T1 and T3 for the control group on Intrusions z score (Z = -.16, p =.88), Repetitions z score (Z = -.58, p =.57), Learning Slope z score (Z = -.23, p =.82) or Semantic Clustering z score (Z = -.91, p =.37), see Table 6.1 and Fig. 6.1.

Table 6.1 *CVLT-II Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int	**Control**	**Int**	**Control**	**Int *Z***	**Int *p***	**Control *Z***	**Control *p***
Total Free Recall	*M* 38.18 *SD*15.82 (*N*=18)	*M* 38 *SD*12.44 (*N*=13)	*M* 40.11 *SD*15.29 (*N*=18)	*M* 44.85 *SD*14.35 (*N*=13)	-1.49	.14	**-2.38***	**.02***
Intrusions z score	*M* .41 *SD*1.09 (*N*=17)	*M* .71 *SD*1.03 (*N*=12)	*M* 1.29 *SD* 2.06 (*N*=17)	*M* .79 *SD*1.36 (*N*=12)	-1.64	.1	-.16	.88
Repetitions z score	*M* .41 *SD*1.44 (*N*=17)	*M* .21 *SD*1.18 (*N*=12)	*M* .53 *SD* 1.19 (*N*=17)	*M* .25 *SD*.72 (*N*=12)	-1.29	.20	-.58	.57
Learning Slope z score	*M* -.69 *SD* 1.24 (*N*=18)	*M* -1.17 *SD* 1.42 (*N*=12)	*M* -1.22 *SD* 1.17 (*N*=18)	*M* -1.04 *SD* 1.03 (*N*=12)	-1.58	.12	-.23	.82
Semantic Clustering z score	*M* -.5 *SD* .62 (*N*=18)	*M* -.29 *SD* .40 (*N*=12)	*M* -.36 *SD* .54 (*N*=18)	*M* -.42 *SD* .47 (*N*=12)	-1.23	.22	-.91	.37

* p<0.05 ** p<0.01

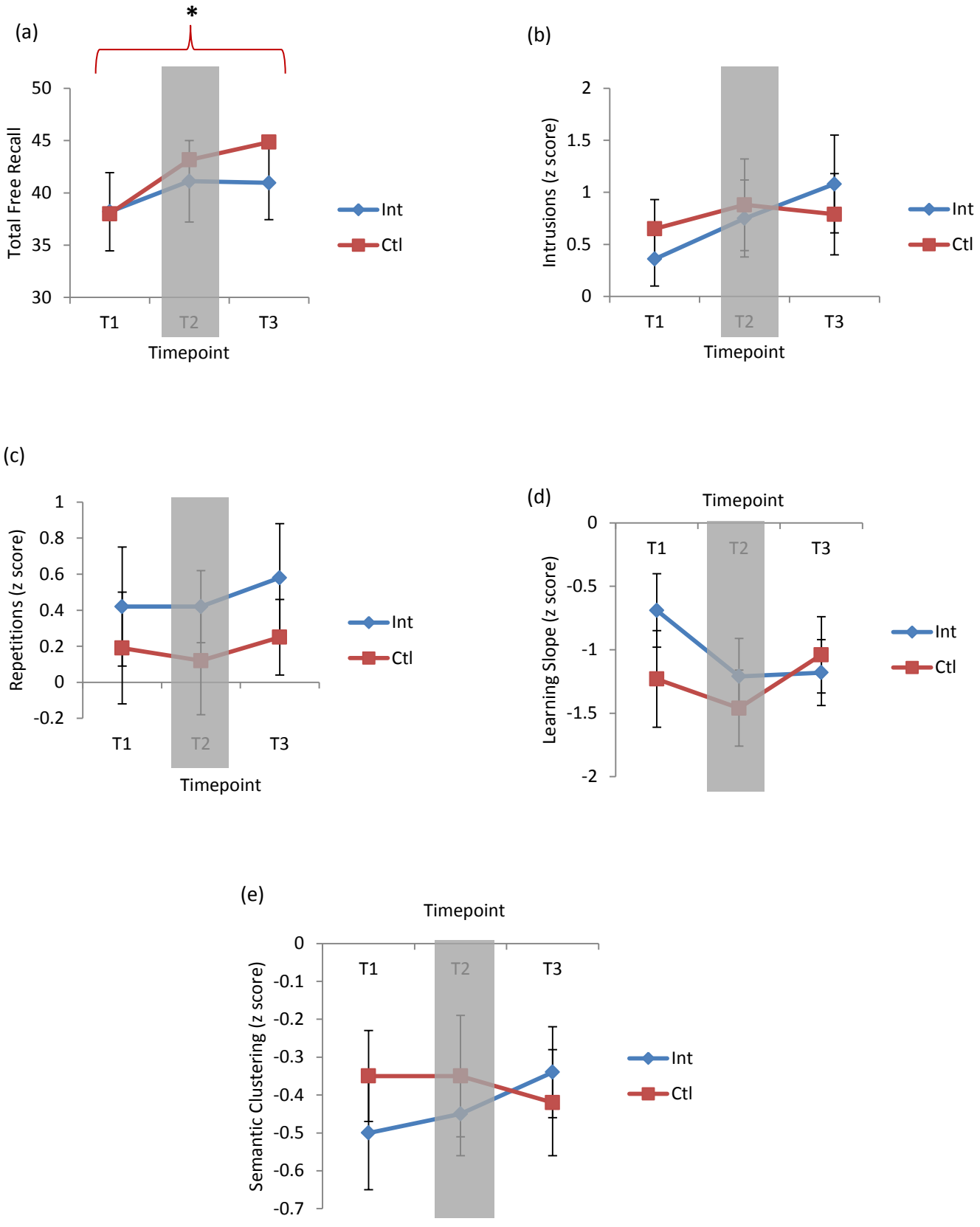


Fig 6.1 *CVLT-II results with (a) Total Free Recall scores; (b) Total Intrusions z score; (c) Total Repetitions z score; (d) Learning Slope z score; and (e) Semantic Clustering z score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.3 Trail Making Test: T1 vs T3

Higher scaled scores on all the Trail Making subscales indicates better performance. A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T3 for the intervention group on Condition 1 Scaled Score (Z = -2.08, p <.05) and Condition 3 Scaled Score (Z = -3.20, p <.01), with participants performing significantly better on these subscales at T3 than T1 (see Table 6.2 and Fig. 6.2). From a clinical perspective, the mean score for the intervention group on Condition 1 Scaled Score increased from *M*5.22 to *M*6.28 and on Condition 3 Scaled Score increased from *M*5 to *M*7.26, however scores remained below the normative data level (10) at T3. See Table 6.2.

No significant difference was seen between T1 and T3 for the intervention group on Condition 2 Scaled Score (Z = -.59, p =.55), Condition 4 Scaled Score (Z = -.75, p =.46), Condition 5 Scaled Score (Z = -1.3, p =.19) or Condition 4 All Errors Scaled Score (Z = -.56, p =.57), see Table 6.2 and Fig. 6.2.

A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 for the control group on Condition 1 Scaled Score (Z = -.11, p =.92), Condition 2 Scaled Score (Z = -1.61, p =.11), Condition 3 Scaled Score (Z = .00, p =1), Condition 4 Scaled Score (Z = -1.29, p =.20), Condition 5 Scaled Score (Z = -1.53, p =.13) or Condition 4 All Errors Scaled Score (Z = -1.37, p =.17), see Table 6.2 and Fig. 6.2.

Table 6.2 *Trail Making Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int	**Control**	**Int**	**Control**	**Int *Z***	**Int *p***	**Control *Z***	**Control *p***
Condition 1 (Scaled)	*M* 5.22 *SD*4.24 (*N*=18)	*M* 6.08 *SD*4.46 (*N*=13)	*M* 6.28 *SD*4.34 (*N*=18)	*M* 5.77 *SD*4.60 (*N*=13)	**-2.08***	**.04***	-.11	.92
Condition 2 (Scaled)	*M* 5.95 *SD*3.92 (*N*=19)	*M* 6 *SD*4.20 (*N*=13)	*M* 6.16 *SD*4.13 (*N*=19)	*M* 7.23 *SD*4.44 (*N*=13)	-.59	.55	-1.61	.11
Condition 3 (Scaled)	*M* 5 *SD*4.43 (*N*=19)	*M* 6.31 *SD*4.44 (*N*=13)	*M* 7.26 *SD*4.68 (*N*=19)	*M* 6.31 *SD*4.82 (*N*=13)	**-3.20****	**.00****	.00	1
Condition 4 (Scaled)	*M* 5.79 *SD*4.60 (*N*=19)	*M* 5.15 *SD*4.20 (*N*=13)	*M* 6.32 *SD*4.28 (*N*=19)	*M* 5.62 *SD*4.61 (*N*=13)	-.75	.46	-1.29	.20
Condition 5 (Scaled)	*M* 6.67 *SD*4.24 (*N*=18)	*M* 6.69 *SD*4.19 (*N*=13)	*M* 7 *SD*4.42 (*N*=18)	*M* 7.54 *SD*3.64 (*N*=13)	-1.3	.19	-1.53	.13
Condition 4 All Errors (Scaled)	*M* 8.05 *SD*4.71 (*N*=19)	*M* 8.77 *SD*3.92 (*N*=13)	*M* 8.74 *SD*4.33 (*N*=19)	*M* 10.31 *SD*1.60 (*N*=13)	-.56	.57	-1.37	.17

* p<0.05 ** p<0.01

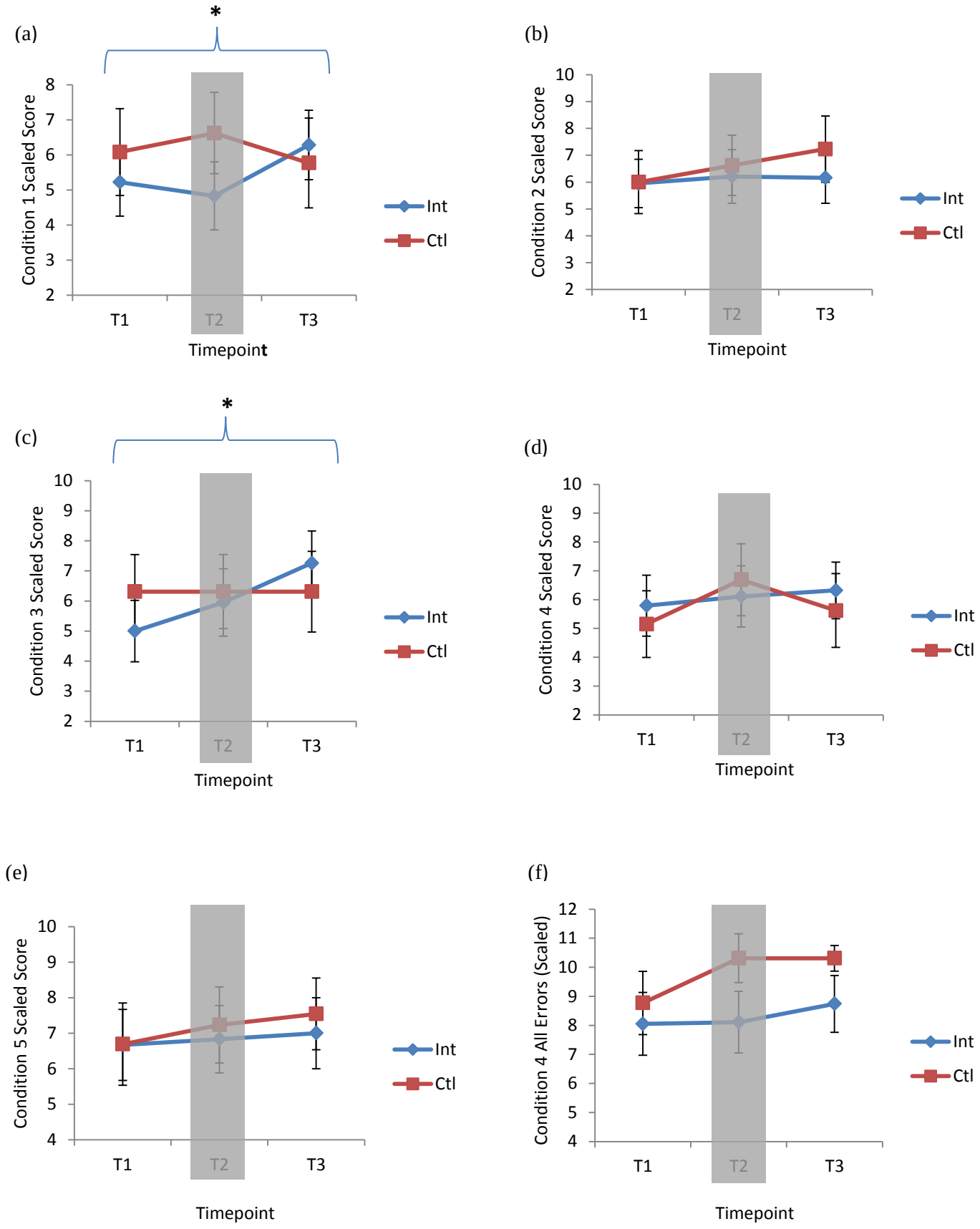


Fig 6.2 *Trail Making Test results with (a) Condition 1 Scaled Score; (b) Condition 2 Scaled Score; (c) Condition 3 Scaled Score; (d) Condition 4 Scaled Score; (e) Condition 5 Scaled Score; and (f) Condition 4 All Errors Scaled Score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.4 Sustained Attention Response Task: T1 vs T3

Higher scores on Total Accuracy and lower scores on Errors of Omission and Errors of Commission indicates better performance on this test. Lower Target Reaction Time scores indicates a faster response to target stimuli and therefore better performance. Lower Reaction Time Error of Commission scores indicates a faster response to clicking the mouse on the number '3' and therefore poorer performance.

A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T3 for the intervention group on Total Accuracy scores (Z = -2.25, p <.05), with the intervention group showing a significant improvement in performance between T1 and T3 (See Table 6.3 and Fig. 6.3). There was no significant difference between T1 and T3 for the intervention group on Errors of Omission (Z = -1.33, p =.18), Errors of Commission (Z = -1.45, p =.15), Target Reaction Time (Z = -.44, p =.66) or Reaction Time Error of Commission scores (Z = -.66, p =.51), see Table 6.3 and Fig. 6.3.

A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 for the control group on Total Accuracy (Z = -.98, p =.33), Errors of Omission (Z = -1.22, p =.22), Errors of Commission (Z = .00, p =1), Target Reaction Time scores (Z = -1.33, p =.18) or Reaction Time Error of Commission scores (Z = -.08, p =.94), see Table 6.3 and Fig. 6.3.

There was an outlier (reference no. 9) in the intervention group on Error of Omission scores at T1, with this person performing very poorly on this measures at T1 when compared to the other participants in their group. When this outlier was removed from analysis, a Wilcoxon Signed Rank Test still found a significant difference in Total Accuracy scores (Z = -2.17, p =.03) between T1 and T3 for the intervention group and found no significant difference in Error of Omission scores (Z = -1.21, p =.23) between T1 and T3 for this group.

Table 6.3 *Sustained Attention Response Task (SART) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=12**	**Int** ***N*=19**	**Control** ***N*=12**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Total Accuracy	*M* 200.05 *SD* 14.83	*M* 184.67 *SD* 47.68	*M* 206.26 *SD* 15.26	*M* 198.92 *SD* 19.30	**-2.25***	**.02***	-.98	.33
Error of Omission	*M* 14.79 *SD* 13.39	*M* 28 *SD* 44.39	*M* 13.84 *SD* 18.80	*M* 13.5 *SD* 14.48	-1.33	.18	-1.22	.22
Error of Commission	*M* 10.16 *SD* 5.44	*M* 12.33 *SD* 6.12	*M* 8.68 *SD* 6.01	*M* 12.58 *SD* 7.53	-1.45	.15	.00	1
Target Reaction Time	*M* 420.16 *SD* 85.34	*M* 416.77 *SD* 95.72	*M* 415.44 *SD* 98.63	*M* 389.75 *SD* 97.24	-.44	.66	-1.33	.18
Reaction Time Error Commission	*M* 195.66 *SD* 104.6	*M* 228.75 *SD* 92.55	*M* 210.39 *SD*123.61	*M* 228.66 *SD* 88.03	-.66	.51	-.08	.94

* p<0.05 ** p<0.01

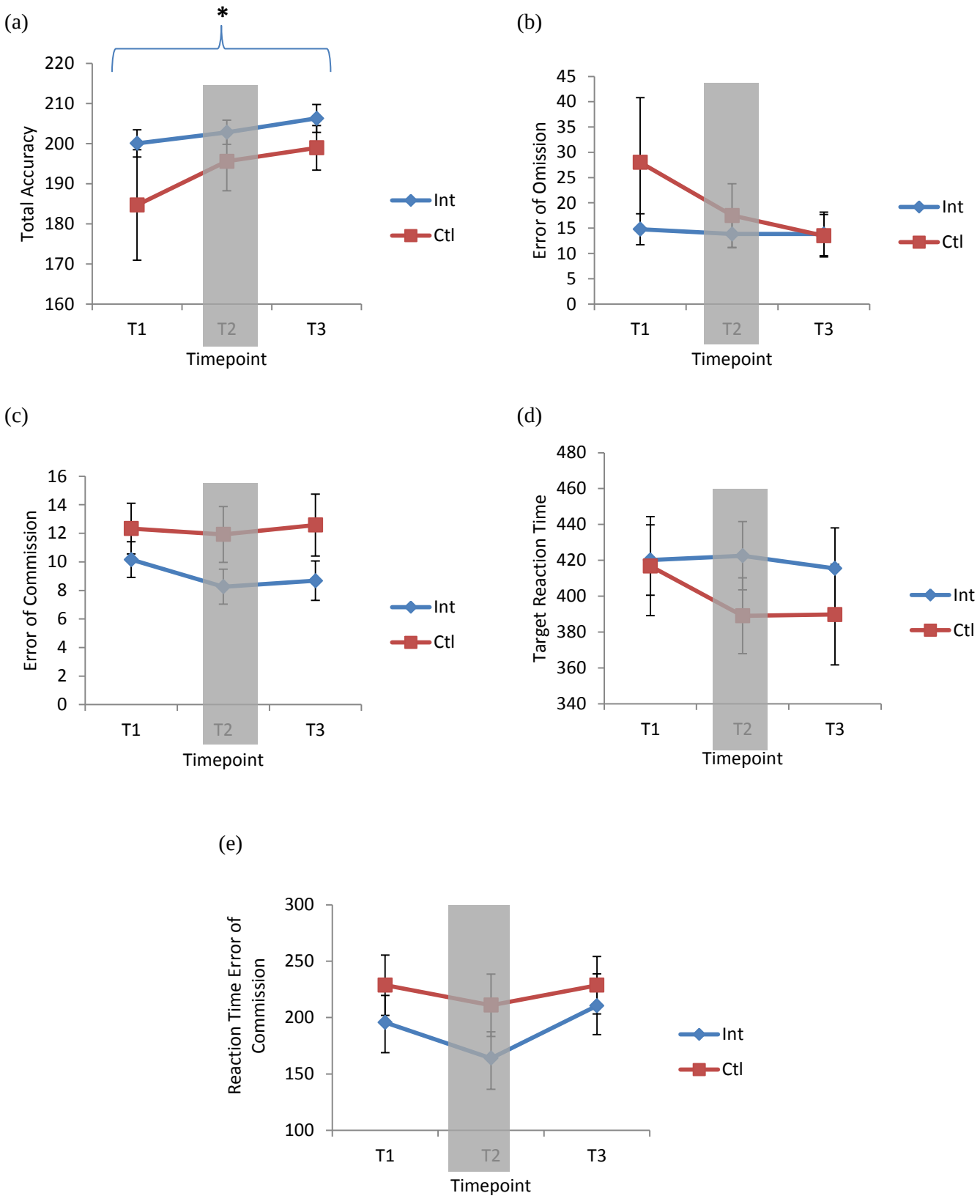


Fig 6.3 *SART Test results with (a) Total Accuracy; (b) Error of Omission; (c) Error of Commission; (d) Target Reaction Time; and (e) Reaction Time Error of Commission for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.5 Digit Span Test: T1 vs T3

Higher scores on all the Digit Span subscales indicates more numbers recalled and therefore better performance. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 for the intervention group on Digit Span Forwards (Z = -.03, p =.97), Digit Span Backwards (Z = -.70, p =.48), Digit Span Sequencing (Z = -1.67, p =.09), Long Digit Span Forwards (Z = -.37, p =.71), Long Digit Span Backwards (Z = -.82, p =.41), Long Digit Span Sequencing (Z = -1.50, p =.14) or Total Digit Span Scaled scores (Z = -1.45, p =.15), see Table 6.4 and Fig. 6.4.

A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T3 for the control group on Digit Span Forwards (Z = .00, p =1), Digit Span Backwards (Z = -1.73, p =.08), Digit Span Sequencing (Z = -1.07, p =.29), Long Digit Span Forwards (Z = -.69, p =.49), Long Digit Span Backwards (Z = -1.27, p =.21), Long Digit Span Sequencing (Z = -1.40, p =.16) or Total Digit Span Scaled scores (Z = -.99, p =.32), see Table 6.4 and Fig. 6.4.

From a clinical perspective, the mean score for the intervention group on Total Digit Span (scaled) increased slightly from T1 (M9.11) to T3 (M9.74), reaching just below normative data levels (10). The mean score for the control group on this measure decreased slightly from T1 (M 8.23) to T3 (M 7.69), remaining below normative data levels at T3. See Table 6.4.

Table 6.4 *Digit Span Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Digit Span Forwards	*M* 10.32 *SD* 3.07	*M* 9 *SD* 1.53	*M* 10.37 *SD* 2.52	*M* 9 *SD* 2.04	-.03	.97	.00	1
Digit Span Backwards	*M* 8.11 *SD* 3.13	*M* 7.54 *SD* 1.90	*M* 8.58 *SD* 3.01	*M* 7.08 *SD* 1.93	-.70	.48	-1.73	.08
Digit Span Sequencing	*M* 7.26 *SD* 3.07	*M* 8 *SD*2	*M* 8.11 *SD* 2.87	*M* 7.15 *SD* 2.64	-1.67	.09	-1.07	.29
Long Digit Span Forwards	*M* 6.74 *SD* 1.76	*M* 5.77 *SD* .93	*M* 6.84 *SD* 1.26	*M* 6 *SD* 1.41	-.37	.71	-.69	.49
Long Digit Span Backwards	*M* 4.42 *SD* 1.68	*M* 4.23 *SD* 1.09	*M* 4.74 *SD* 1.56	*M* 3.92 *SD* 1.32	-.82	.41	-1.27	.21
Long Digit Span Sequencing	*M* 5.16 *SD* 1.80	*M* 5.77 *SD* 1.01	*M* 5.68 *SD* 1.60	*M* 5.15 *SD* 1.46	-1.50	.14	-1.40	.16
Total Digit Span (Scaled)	*M* 9.11 *SD* 3.91	*M* 8.23 *SD* 2.24	*M* 9.74 *SD* 3.66	*M* 7.69 *SD* 2.87	-1.45	.15	-.99	.32

* p<0.05 ** p<0.01

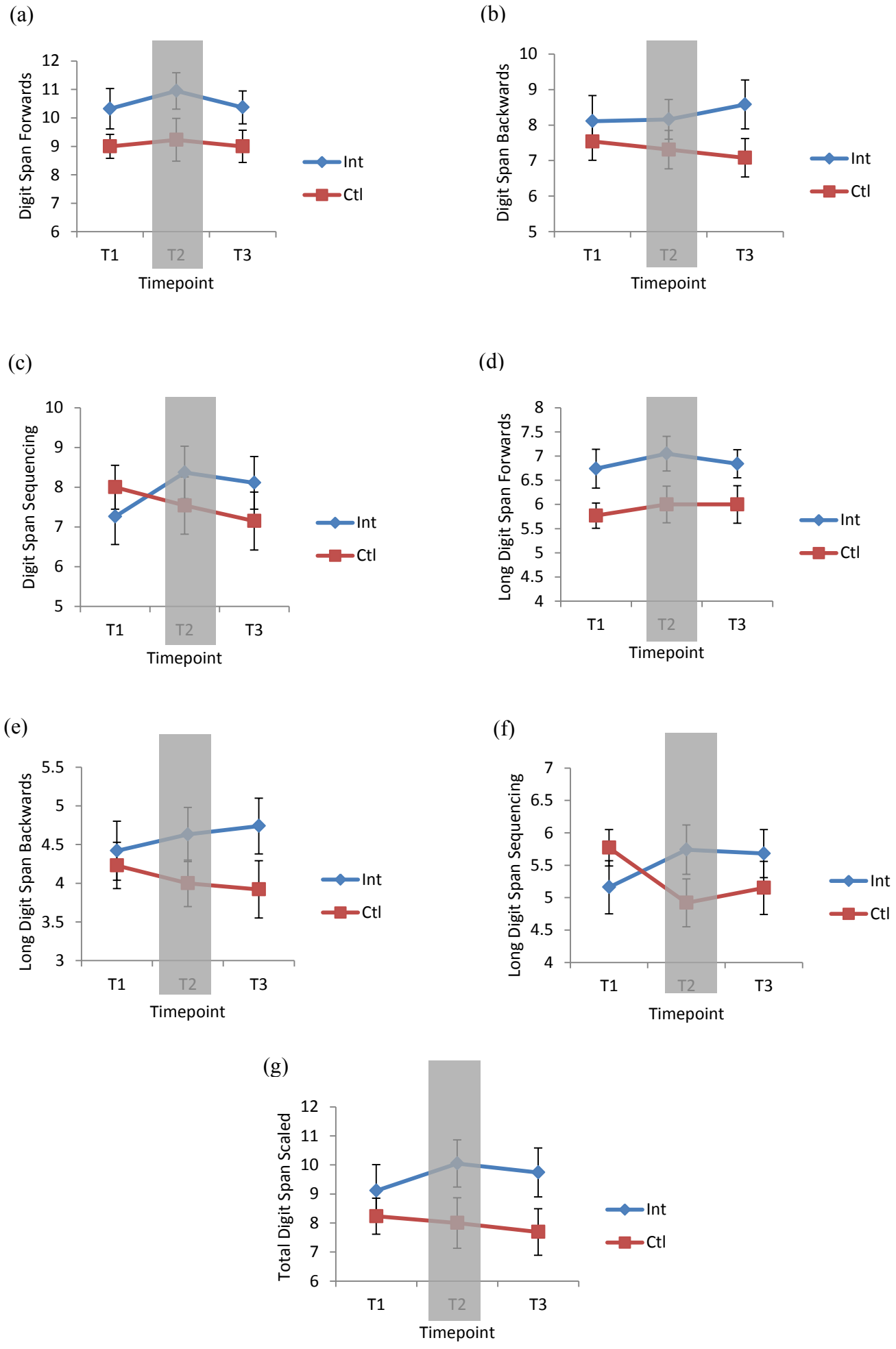


Fig 6.4 *Digit Span results with (a) Digit Span Forwards; (b) Digit Span Backwards; (c) Digit Span Sequencing; (d) Long Digist Span Forwards; (e) Long Digit Span Backwards; (f) Long Digit Span Sequencing; and (g) Total Digit Span Scaled Score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.6 Hospital Anxiety and Depression Scale: T1 vs T3

Higher scores on Anxiety, Depression and Total Distress subscales indicates higher levels of distress. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 for the intervention group on Anxiety (Z = -1.07, p =.29), Depression (Z = -1.2, p =.23) or Total Distress scores (Z = -1.31, p =.19), see Table 6.5 and Fig. 6.5. There was no significant difference between T1 and T3 for the control group on Anxiety (Z = -1.07, p =.29), Depression (Z = -.56, p =.58) or Total Distress scores (Z = -1.02, p =.31), see Table 6.5 and Fig. 6.5.

From a clinical perspective, the mean score for the intervention group on Total Distress decreased from T1 (M12.68) to T3 (M10.95), but remained above normative data levels (9.82) at T3. Similarly, the mean score for the control group decreased slightly from T1 (M15.62) to T3 (M14.23) on this measure, but remained above normative data levels (9.82) at T3. See Table 6.5.

Frequencies of participants in the various categories for anxiety and depression (normal, mild, moderate and severe) were compared between T1 and T3 (see Tables 6.6 and 6.7). For the intervention group, the number of participants in the moderate and severe categories for anxiety reduced from n=5 at T1 to n=2 at T3 and the number of participants in the normal range increased from n=13 at T1 to n=14 at T3 in this group. The number of intervention group participants in the moderate and severe categories for depression reduced from n=4 at T1 to n=3 at T3, although there was one person in the 'severe' category at T3 and none in this category at T1. The number of intervention group participants in the normal range for depression stayed the same between T1 and T3 (n=13).

For the control group, the number of participants in the moderate and severe categories for anxiety stayed the same (n=3) between T1 and T3, with two participants moving into the 'severe' category at T3. The number of control group participants in the

normal range increased from *n*=8 at T1 to *n*=9 at T3. The number of control group participants in the moderate and severe categories for depression stayed the same (*n*=3) between T1 and T3, with all three falling into the 'moderate' category at both timepoints. The number of control group participants in the normal range increased from *n*=5 at T1 to *n*=6 at T3.

Table 6.5 *Hospital Anxiety and Depression Scale (HADS) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Anxiety	*M* 6.79 *SD* 4.26	*M* 7.85 *SD* 4.08	*M* 5.74 *SD* 4.63	*M* 7.08 *SD* 4.72	-1.07	.29	-1.07	.29
Depression	*M* 5.89 *SD* 4.07	*M* 7.77 *SD* 3.88	*M* 5.21 *SD* 4.65	*M* 7.15 *SD* 4.63	-1.2	.23	-.56	.58
Distress	*M* 12.68 *SD* 7.68	*M* 15.62 *SD* 6.10	*M* 10.95 *SD* 8.77	*M* 14.23 *SD* 7.44	-1.31	.19	-1.02	.31

* p<0.05 ** p<0.01

Table 6.6 *Anxiety at T1and T3: Results by Category (Frequencies)*

	Timepoint 1		**Timepoint 3**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**
Normal	13	8	14	9
Mild	1	2	3	1
Moderate	4	3	1	1
Severe	1	0	1	2

Table 6.7 *Depression at T1 and T3: Results by Category (Frequencies)*

	Timepoint 1		**Timepoint 3**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**
Normal	13	5	13	6
Mild	2	5	3	4
Moderate	4	3	2	3
Severe	0	0	1	0

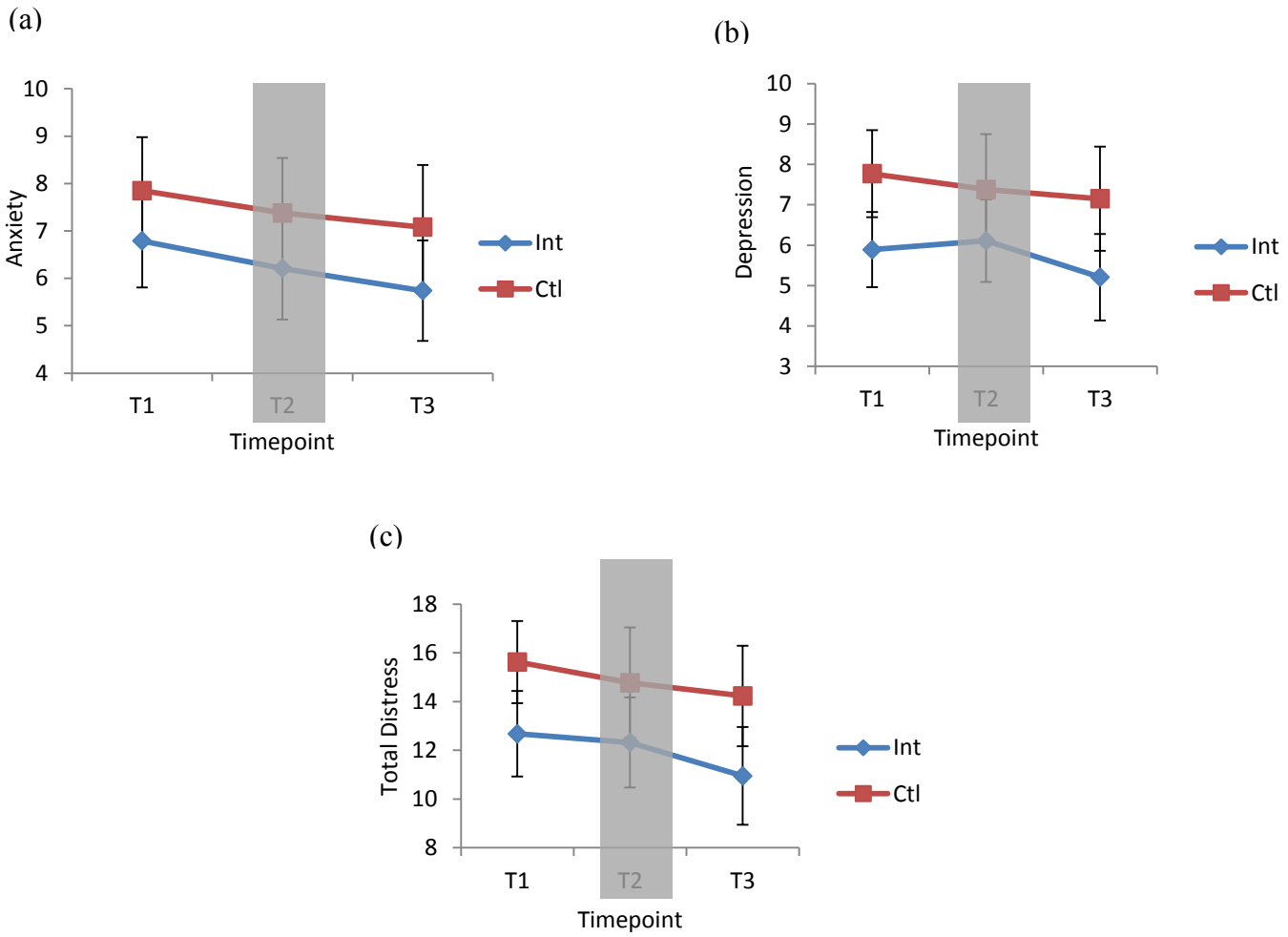


Fig 6.5 *HADS results with (a) Anxiety; (b) Depression; and (c) Distress for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.7 Satisfaction With Life Scale: T1 vs T3

Higher scores on this measure indicate more satisfaction with life. A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T3 on Satisfaction With Life scores for the intervention group (Z = -.29, p =.78), or the control group (Z = -.14, p =.89), see Table 6.8 and Fig. 6.6.

From a clinical perspective, the mean score for the intervention group on Satisfaction With Life increased slightly from T1 (M20.35) to T3 (M20.53), but remained below normative data levels (26.46) at T3. Similarly, the mean score for the control group increased slightly from T1 (M17.23) to T3 (M17.38) on this measure, but remained below normative data levels (26.46) at T3. See Table 6.8.

Table 6.8 *Satisfaction With Life Scale (SWLS) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		Timepoint 3		Wilcoxon		Wilcoxon	
	Int *N*=17	Control *N*=13	Int *N*=17	Control *N*=13	Int *Z*	Int *p*	Control *Z*	Control *p*
Satisfaction With Life	*M* 20.35 *SD* 8.75	*M* 17.23 *SD* 5.93	*M* 20.53 *SD* 8.59	*M* 17.38 *SD* 7.97	-.29	.78	-.14	.89

* p<0.05 ** p<0.01

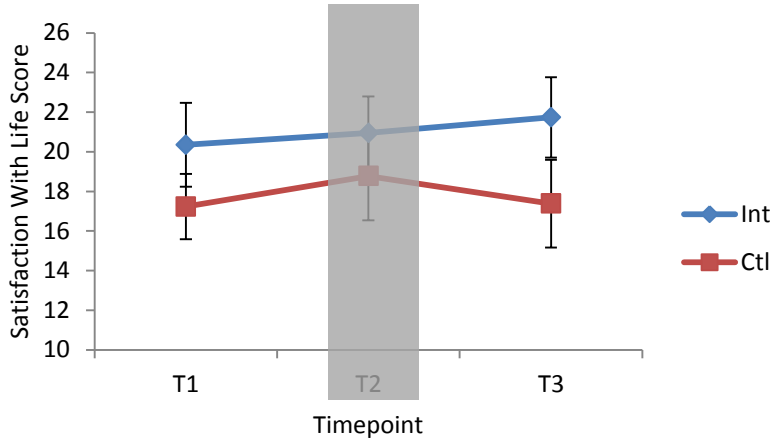


Fig 6.6 *Satisfaction With Life Scale results for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.8 Community Integration Questionnaire: T1 vs T3

Higher scores on all the CIQ subscales and on the total CIQ score indicate better community integration. A Wilcoxon Signed Rank Test revealed no significant difference between T1 and T3 for the intervention group on Home Integration (Z = -1, p =.32), Social Integration (Z = -1.06, p =.29), Productivity (Z = -.38, p =.70) or Total Community Integration (Z = -.57, p =.57), see Table 6.9 and Fig. 6.7.

A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 for the control group on Home Integration (Z = -1.19, p =.24), Social Integration (Z = -.99, p =.32), Productivity (Z = -1.16, p =.25) or Total Community Integration (Z = -1.42, p =.16), see Table 6.9 and Fig. 6.7.

From a clinical perspective, the mean score for the intervention group on Total Community Integration increased slightly from T1 (*M*13.29) to T3 (*M*14.32), but remained below normative data levels (19.12) at T3. Similarly, the mean score for the control group increased slightly from T1 (*M*14.5) to T3 (*M*15.92) on this measure, but remained below normative data levels (19.12) at T3. See Table 6.9.

Table 6.9 *Community Integration Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Home Integration	*M* 3.71 *SD* 2.19	*M* 4.65 *SD* 3.21	*M* 4.42 *SD* 2.77	*M* 5.23 *SD* 2.80	-1	.32	-1.19	.24
Social Integration	*M* 6.63 *SD* 2.45	*M* 7.23 *SD* 2.13	*M* 7.16 *SD* 2.03	*M* 7.69 *SD* 1.93	-1.06	.29	-.99	.32
Productivity	*M* 2.95 *SD* 1.93	*M* 2.62 *SD* 1.71	*M* 2.74 *SD* 1.85	*M* 3 *SD* 1.35	-.38	.70	-1.16	.25
Total CIQ Score	*M* 13.29 *SD* 5.63	*M* 14.5 *SD* 5.27	*M* 14.32 *SD* 5.27	*M* 15.92 *SD* 4.01	-.57	.57	-1.42	.16

* p<0.05 ** p<0.01

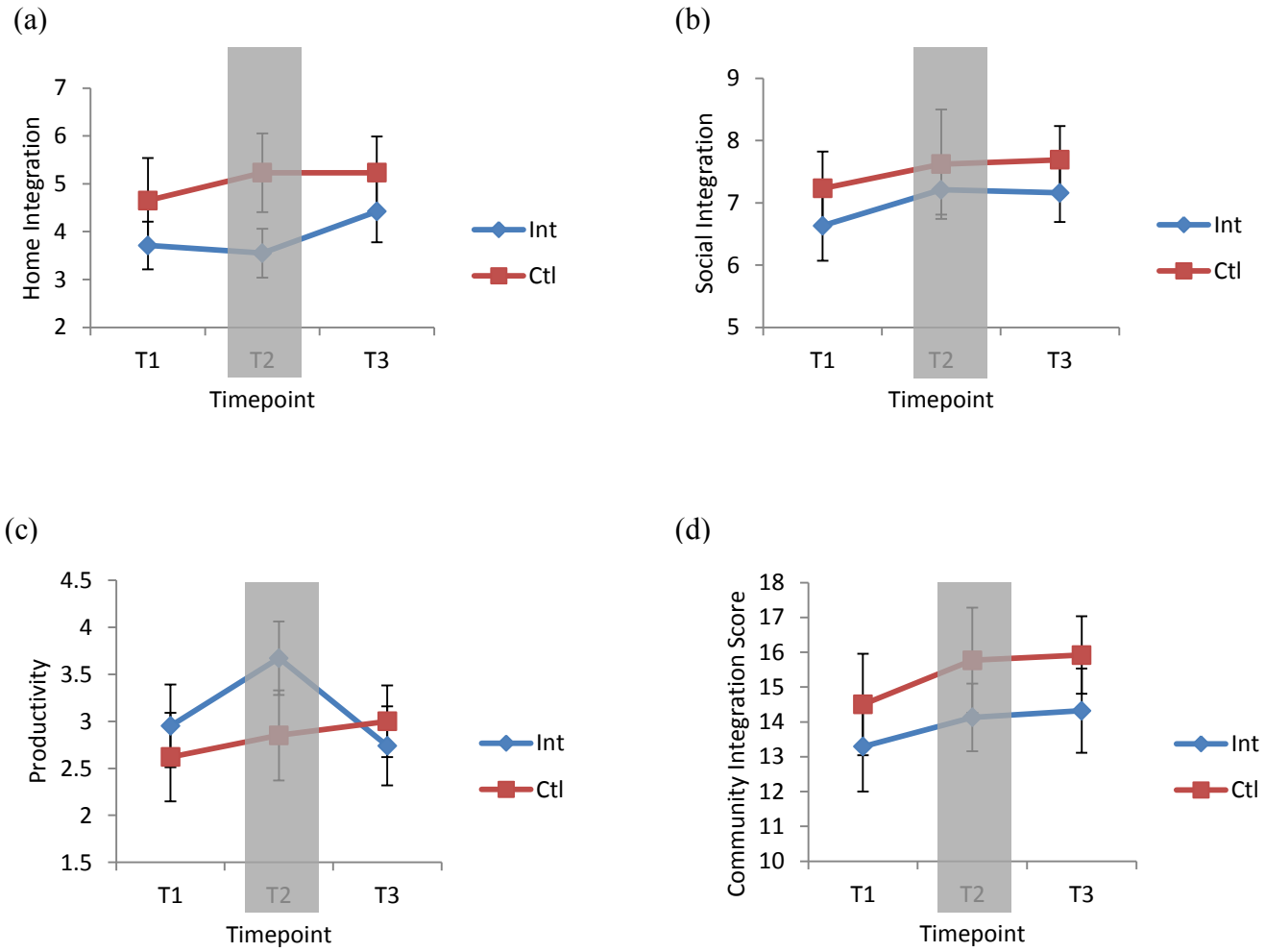


Fig 6.7 *Community Integration Scores with (a) Home Integration; (b) Social Integration; (c) Productivity; and (d) Total CIQ Score for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.9 Cognitive Group Self-Evaluation Questionnaire: T1 vs T3

Higher scores on this measure indicate a more positive rating by a person for their cognitive abilities and how deficits impact on their lives. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 on Cognitive Group Self Evaluation scores for the intervention group (Z = -.98, p =.33). A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T3 on Cognitive Group Self Evaluation scores for the control group (Z = -2.06, p <.05), with participants rating their cognitive functioning and the impact of cognitive defictis on their lives, more favourably at T3 than T1. (see Table 6.10 and Fig. 6.8).

Table 6.10 *Cognitive Group Self Evaluation Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		Timepoint 3		Wilcoxon		Wilcoxon	
	Int ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Total CGSE Score	*M* 80.31 *SD* 20.51	*M* 67.92 *SD* 21.74	*M* 82.81 *SD* 20.93	*M* 80.62 *SD* 18.85	-.98	.33	**-2.06***	**.04***

* p<0.05 ** p<0.01

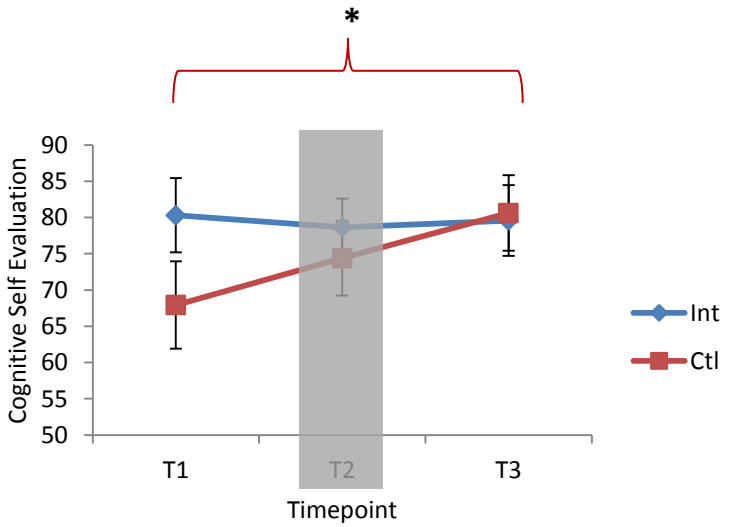


Fig 6.8 *Cognitive Group Self Evaluation Questionnaire Results for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.10 Knowledege of Brain Injury Questionnaire: T1 vs T3

Higher scores on this measure indicate a more positive rating by a person for their knowledge of brain injury. A Wilcoxon Signed Rank Test showed no significant difference between T1 and T3 on Knowledge of Brain Injury scores for the intervention group (Z = -1.79, p =.07) or the control group (Z = -.80, p =.42), see Table 6.11 and Fig. 6.9.

Table 6.11 *Knowledge of Brain Injury Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T1 v T3)*

	Timepoint 1		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=18**	**Control** ***N*=12**	**Int** ***N*=18**	**Control** ***N*=12**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Knowledge of Brain Injury	*M* 30.17 *SD* 4.93	*M* 30 *SD* 7.54	*M* 32.94 *SD* 3.90	*M* 32.67 *SD* 3.80	-1.79	.07	-.80	.42

* p<0.05 ** p<0.01

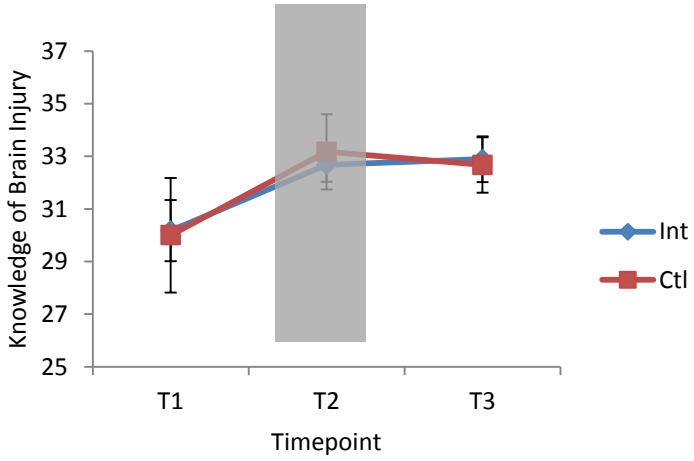


Fig 6.9 *Knowledge of Brain Injury Questionnaire Results for Intervention (Int) and Control (Ctl) groups across timepoints T1 to T3*

6.11 Summary of Significant Effects T1 vs T3

6.11.1 Signifcant Effects for Intervention Group

A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T3 for the intervention group on Condition 1 Scaled Score (Z = -2.08, p <.05) and Condition 3 Scaled Score (Z = -3.20, p <.01) of the Trail Making Test, with participants performing significantly better on these subscales at T3 than T1. From a clinical perspective, the mean score for the intervention group on Condition 1 Scaled Score increased from *M*5.22 to *M*6.28 and on Condition 3 Scaled Score increased from *M*5 to *M*7.26, however scores remained below the normative data level (10) at T3.

On the SART test, a Wilcoxon Signed Rank Test revealed a significant difference between T1 and T3 for the intervention group on Total Accuracy scores (Z = -2.25, p <.05), with the intervention group showing a significant improvement in performance between T1 and T3. Total Accuracy scores relate to the number of correct responses a person makes, including clicking the mouse when they see the target stimuli and not clicking it when they see the number '3' (that is, inhibiting their response). When an outlier was removed from analysis, a Wilcoxon Signed Rank Test still found a significant difference in Total Accuracy scores (Z = -2.17, p <.05) between T1 and T3 for the intervention group.

6.11.2 Signifcant Effects for Control Group

A Wilcoxon Signed Rank Test showed a significant difference between T1 and T3 for the control group on the Total Free Recall subscale of the CVLT-II test (Z = -2.38, p <.05), with participants performing significantly better at T3 than T1. A Wilcoxon Signed Rank Test revealed a significant difference between T1 and T3 on Cognitive Group Self Evaluation scores for the control group (Z = -2.06, p <.05), with participants rating their cognitive functioning significantly higher at T3 than T1.

6.12 Data Analysis T2 vs T3

Data were screened for normality, skewness, kurtosis and to check for outliers. Within group differences were examined using Wilcoxon Signed Rank Tests. Within groups factor was timepoint (post-intervention and 6 months after completion of intervention) and dependent measures were the dependent variables for each of the tests and questionnaires used in the study. SPSS version 22 was used for all statistical analyses.

6.13 California Verbal Learning Test: T2 vs T3

On the Total Free Recall subscale, a higher score indicates more words recalled, and therefore better performance. On the intrusions and repetitions subscales, a lower z score indicates better performance due to less intrusions or repetitions being made. On the Learning Slope and Semantic Clustering subscales, a higher z score indicates better performance.

A Wilcoxon Signed Rank Test revealed no significant difference between T2 and T3 for the intervention group on Total Free Recall (Z = -.1, p =.91), Intrusions z score (Z = -1.41, p =.16), Repetitions z score (Z = -.05, p =.96), Learning Slope z score (Z = -.17, p =.87) or Semantic Clustering z score (Z = -.55, p =.58), see Table 6.12 and Fig. 6.10.

A Wilcoxon Signed Rank Test revealed a significant difference between T2 and T3 for the control group on Learning Slope scores (Z = -2.07, p <.05), with participants performing significantly better on this measure at T3 than T2 (see 6.12 and Fig. 6.10). No significant difference was seen between T2 and T3 for the control group on Total Free Recall (Z = -.91, p =.36), Intrusions z score (Z = -.36, p =.72), Repetitions z score (Z = -.43, p =.67) or Semantic Clustering z score (Z = -1, p =.32), see Table 6.12 and Fig. 6.10.

Table 6.12 *CVLT-II Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		Timepoint 3		Wilcoxon		Wilcoxon	
	Int	**Control**	**Int**	**Control**	**Int *Z***	**Int *p***	**Control *Z***	**Control *p***
Total Free Recall	*M* 40.94 *SD*17.43 (*N*=18)	*M* 43.15 *SD*14.38 (*N*=13)	*M* 40.11 *SD*15.29 (*N*=18)	*M* 44.85 *SD*14.35 (*N*=13)	-.11	.91	-.91	.36
Intrusions z score	*M* .85 *SD*1.56 (*N*=17)	*M* .88 *SD*1.64 (*N*=12)	*M* 1.29 *SD* 2.06 (*N*=17)	*M* .79 *SD*1.36 (*N*=12)	-1.41	.16	-.36	.72
Repetitions z score	*M* .44 *SD*.88 (*N*=17)	*M* .17 *SD*1.11 (*N*=12)	*M* .53 *SD* 1.19 (*N*=17)	*M* .25 *SD*.72 (*N*=12)	-.05	.96	-.43	.67
Learning Slope z score	*M* -1.25 *SD* 1.32 (*N*=18)	*M* -1.63 *SD* .93 (*N*=12)	*M* -1.22 *SD* 1.17 (*N*=18)	*M* -1.04 *SD* 1.03 (*N*=12)	-.17	.87	**-2.07***	**.04***
Semantic Clustering z score	*M* -.44 *SD* .51 (*N*=18)	*M* -.29 *SD* .58 (*N*=12)	*M* -.36 *SD* .54 (*N*=18)	*M* -.42 *SD* .47 (*N*=12)	-.55	.58	-1	.32

* p<0.05 ** p<0.01

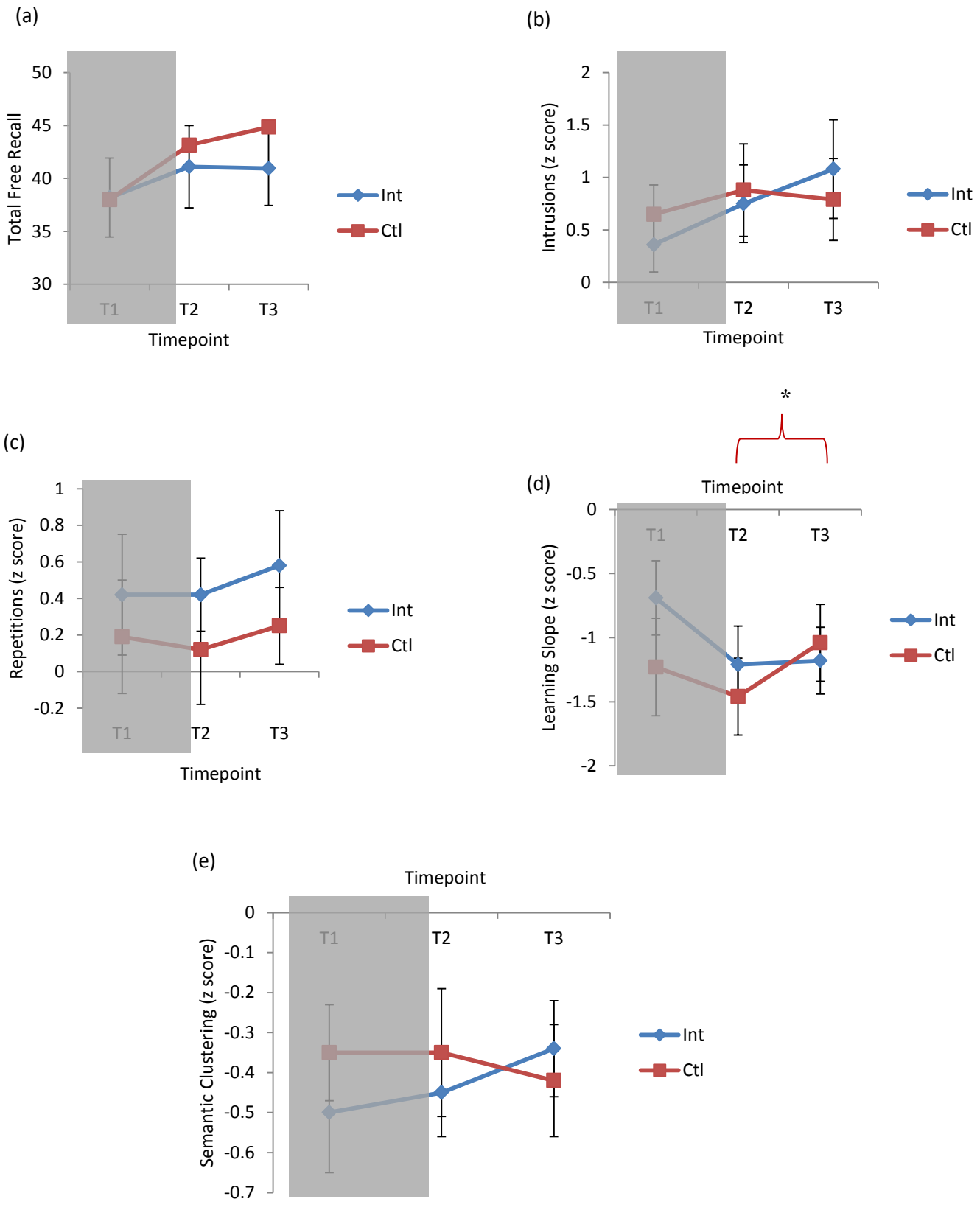


Fig 6.10 *CVLT-II results with (a) Total Free Recall scores; (b) Total Intrusions z score; (c) Total Repetitions z score; (d) Learning Slope z score; and (e) Semantic Clustering z score for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.14 Trail Making Test: T2 vs T3

Higher scaled scores on all the Trail Making subscales indicates better performance. A Wilcoxon Signed Rank Test showed a significant difference between T2 and T3 for the intervention group on Condition 1 Scaled Score (Z = -2.25, p <.05) and Condition 3 Scaled Score (Z = -2.46, p <.05), with participants' performance improving between T2 and T3 on both subscales. A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 for the intervention group on Condition 2 Scaled Score (Z = -.20, p =.84), Condition 4 Scaled Score (Z = -.36, p =.72), Condition 5 Scaled Score (Z = -.96, p =.34) or Condition 4 All Errors Scaled Score (Z = -.60, p =.55), see Table 6.13 and Fig. 6.11.

A Wilcoxon Signed Rank Test showed no significant difference between T2 and T3 for the control group on Condition 1 Scaled Score (Z = -.94, p =.35), Condition 2 Scaled Score (Z = -1.03, p =.31), Condition 3 Scaled Score (Z = -.36, p =.72), Condition 4 Scaled Score (Z = -1.19, p =.23), Condition 5 Scaled Score (Z = -.95, p =.34) or Condition 4 All Errors Scaled Score (Z = -.43, p =.67), see Table 6.13 and Fig. 6.11.

From a clinical perspective, the only mean score to reach normative data levels was on Condition 4 All Errors (scaled score) for the control group. Mean scores for this group stayed the same between T2 (M10.31) and T3 (M10.31). See Table 6.13.

Table 6.13 *Trail Making Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int	**Control**	**Int**	**Control**	**Int *Z***	**Int *p***	**Control *Z***	**Control *p***
Condition 1 (Scaled)	*M* 4.83 *SD*4.11 (*N*=18)	*M* 6.62 *SD*4.19 (*N*=13)	*M* 6.28 *SD*4.34 (*N*=18)	*M* 5.77 *SD*4.60 (*N*=13)	**-2.25***	**.02***	-.94	.35
Condition 2 (Scaled)	*M* 6.21 *SD*4.34 (*N*=19)	*M* 6.62 *SD*4.03 (*N*=13)	*M* 6.16 *SD*4.13 (*N*=19)	*M* 7.23 *SD*4.44 (*N*=13)	-.20	.84	-1.03	.31
Condition 3 (Scaled)	*M* 5.95 *SD*4.89 (*N*=19)	*M* 6.31 *SD*4.42 (*N*=13)	*M* 7.26 *SD*4.68 (*N*=19)	*M* 6.31 *SD*4.82 (*N*=13)	**-2.46***	**.01***	-.36	.72
Condition 4 (Scaled)	*M* 6.11 *SD*4.63 (*N*=19)	*M* 6.69 *SD*4.50 (*N*=13)	*M* 6.32 *SD*4.28 (*N*=19)	*M* 5.62 *SD*4.61 (*N*=13)	-.36	.72	-1.19	.23
Condition 5 (Scaled)	*M* 6.83 *SD*4.19 (*N*=18)	*M* 7.23 *SD*3.85 (*N*=13)	*M* 7 *SD*4.42 (*N*=18)	*M* 7.54 *SD*3.64 (*N*=13)	-.96	.34	-.95	.34
Condition 4 All Errors (Scaled)	*M* 8.11 *SD*4.47 (*N*=19)	*M* 10.31 *SD*3.01 (*N*=13)	*M* 8.74 *SD*4.33 (*N*=19)	*M* 10.31 *SD*1.60 (*N*=13)	-.60	.55	-.43	.67

* p<0.05 ** p<0.01

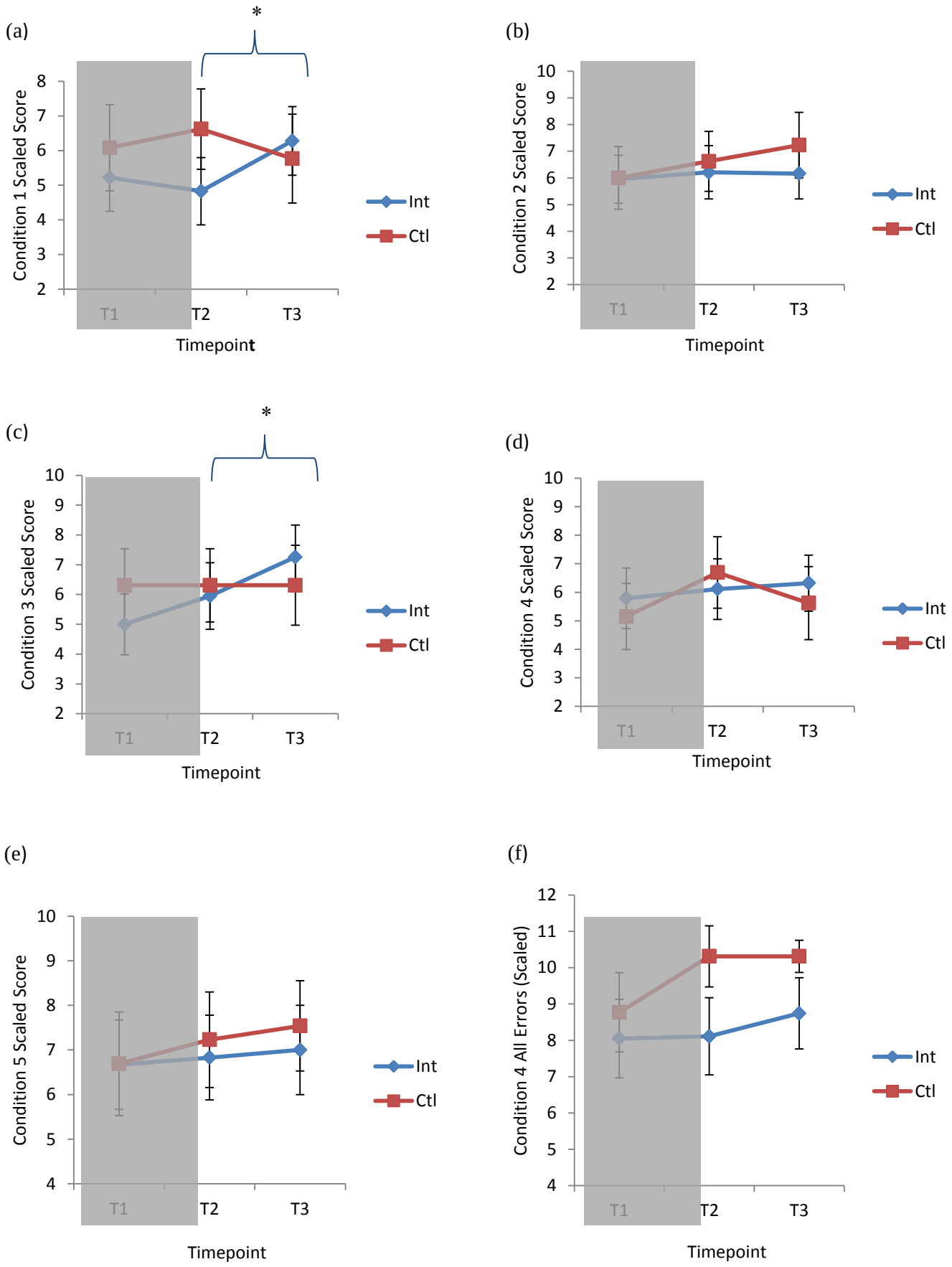


Fig 6.11 *Trail Making Test results with (a) Condition 1 Scaled Score; (b) Condition 2 Scaled Score; (c) Condition 3 Scaled Score; (d) Condition 4 Scaled Score; (e) Condition 5 Scaled Score; and (f) Condition 4 All Errors Scaled Score for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.15 Sustained Attention Response Task: T2 vs T3

Higher scores on Total Accuracy and lower scores on Errors of Omission and Errors of Commission indicates better performance on this test. Lower Target Reaction Time scores indicates a faster response to target stimuli and therefore better performance and lower Reaction Time Error of Commission scores indicates a faster response to clicking the mouse on the number '3' and therefore poorer performance.

A Wilcoxon Signed Rank Test revealed no significant difference between T2 and T3 for the intervention group on Total Accuracy (Z = -.91, p =.37), Errors of Omission (Z = -.17, p =.87), Errors of Commission (Z = -.57, p =.57), Target Reaction Time (Z = -.56, p =.57) or Reaction Time Error of Commission scores (Z = -1.09, p =.28), see Table 6.14 and Fig. 6.12.

A Wilcoxon Signed Rank Test revealed no significant difference between T2 and T3 for the control group on Total Accuracy (Z = -1.18, p =.24), Errors of Omission (Z = -1.28, p =.20), Errors of Commission (Z = -1.03, p =.30), Target Reaction Time scores (Z = -.55, p =.58) or Reaction Time Error of Commission scores (Z = -1.41, p =.16), see Table 6.14 and Fig. 6.12.

Table 6.14 *Sustained Attention Response Task (SART) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=12**	**Int** ***N*=19**	**Control** ***N*=12**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Total Accuracy	*M* 202.79 *SD* 13.15	*M* 195.58 *SD* 25.42	*M* 206.26 *SD* 15.26	*M* 198.92 *SD* 19.30	-.91	.37	-1.18	.24
Error of Omission	*M* 13.84 *SD* 11.98	*M* 17.50 *SD* 21.8	*M* 13.84 *SD* 18.80	*M* 13.5 *SD* 14.48	-.17	.87	-1.28	.20
Error of Commission	*M* 8.26 *SD* 5.30	*M* 11.92 *SD* 6.78	*M* 8.68 *SD* 6.01	*M* 12.58 *SD* 7.53	-.57	.57	-1.03	.30
Target Reaction Time	*M* 422.56 *SD* 83	*M* 389.06 *SD* 73.03	*M* 415.44 *SD* 98.63	*M* 389.75 *SD* 97.24	-.56	.57	-.55	.58
Reaction Time Error Commission	*M* 164.01 *SD* 101.69	*M* 210.92 *SD* 95.50	*M* 210.39 *SD*123.61	*M* 228.66 *SD* 88.03	-1.09	.28	-1.41	.16

* $p<0.05$ ** $p<0.01$

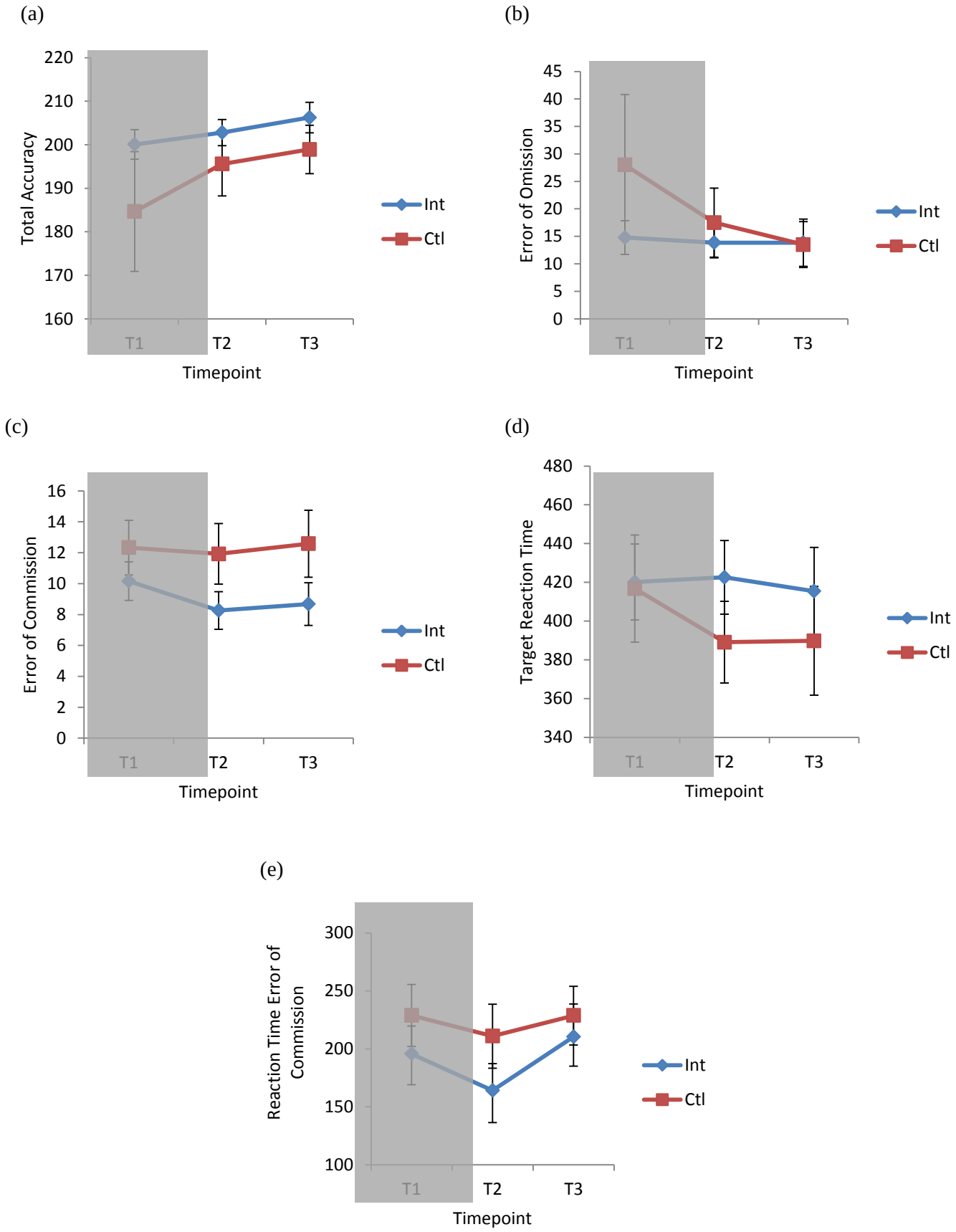


Fig 6.12 *SART Test results with (a) Total Accuracy; (b) Error of Omission; (c) Error of Commission; (d) Target Reaction Time; and (e) Reaction Time Error of Commission for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.16 Digit Span Test: T2 vs T3

Higher scores on all Digit Span subscales indicates more numbers recalled and therefore better performance. A Wilcoxon Signed Rank Test showed no significant difference between T2 and T3 for the intervention group on Digit Span Forwards (Z = -1.72, p =.09), Digit Span Backwards (Z = -.92, p =.34), Digit Span Sequencing (Z = -.42, p =.68), Long Digit Span Forwards (Z = -.95, p =.34), Long Digit Span Backwards (Z = -.53, p =.60), Long Digit Span Sequencing (Z = -.19, p =.85) or Total Digit Span Scaled scores (Z = -.89, p =.38), see Table 6.15 and Fig. 6.13.

A Wilcoxon Signed Rank Test revealed no significant difference between T2 and T3 for the control group on Digit Span Forwards (Z = -.26, p =.80), Digit Span Backwards (Z = -.79, p =.43), Digit Span Sequencing (Z = -.78, p =.44), Long Digit Span Forwards (Z = -.09, p =.93), Long Digit Span Backwards (Z = -.38, p =.71), Long Digit Span Sequencing (Z = -.55, p =.58) or Total Digit Span Scaled scores (Z = -.62, p =.53), see Table 6.15 and Fig. 6.13.

From a clinical perspective, the mean score for the intervention group on Total Digit Span (scaled) stayed around the normative data level of 10 at T2 (M10.05) and T3 (M9.74). The mean score for the control group on this measure decreased slightly from T2 (M8) to T3 (M7.69) and remained below normative data levels at T3. See Table 6.15.

Table 6.15 *Digit Span Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Digit Span Forwards	*M* 10.95 *SD*2.78	*M* 9.23 *SD* 2.71	*M* 10.37 *SD* 2.52	*M* 9 *SD* 2.04	-1.72	.09	-.26	.80
Digit Span Backwards	*M* 8.16 *SD* 2.46	*M* 7.31 *SD* 1.93	*M* 8.58 *SD* 3.01	*M* 7.08 *SD* 1.93	-.92	.34	-.79	.43
Digit Span Sequencing	*M* 8.37 *SD* 2.89	*M* 7.54 *SD*2.60	*M* 8.11 *SD* 2.87	*M* 7.15 *SD* 2.64	-.42	.68	-.78	.44
Long Digit Span Forwards	*M* 7.05 *SD* 1.58	*M* 6 *SD* 1.35	*M* 6.84 *SD* 1.26	*M* 6 *SD* 1.41	-.95	.34	-.09	.93
Long Digit Span Backwards	*M* 4.63 *SD* 1.54	*M* 4 *SD* 1.08	*M* 4.74 *SD* 1.56	*M* 3.92 *SD* 1.32	-.53	.60	-.38	.71
Long Digit Span Sequencing	*M* 5.74 *SD* 1.66	*M* 4.92 *SD* 1.32	*M* 5.68 *SD* 1.60	*M* 5.15 *SD* 1.46	-.19	.85	-.55	.58
Total Digit Span (Scaled)	*M* 10.05 *SD* 3.52	*M* 8 *SD* 3.14	*M* 9.74 *SD* 3.66	*M* 7.69 *SD* 2.87	-.89	.38	-.62	.53

* p<0.05 ** p<0.01

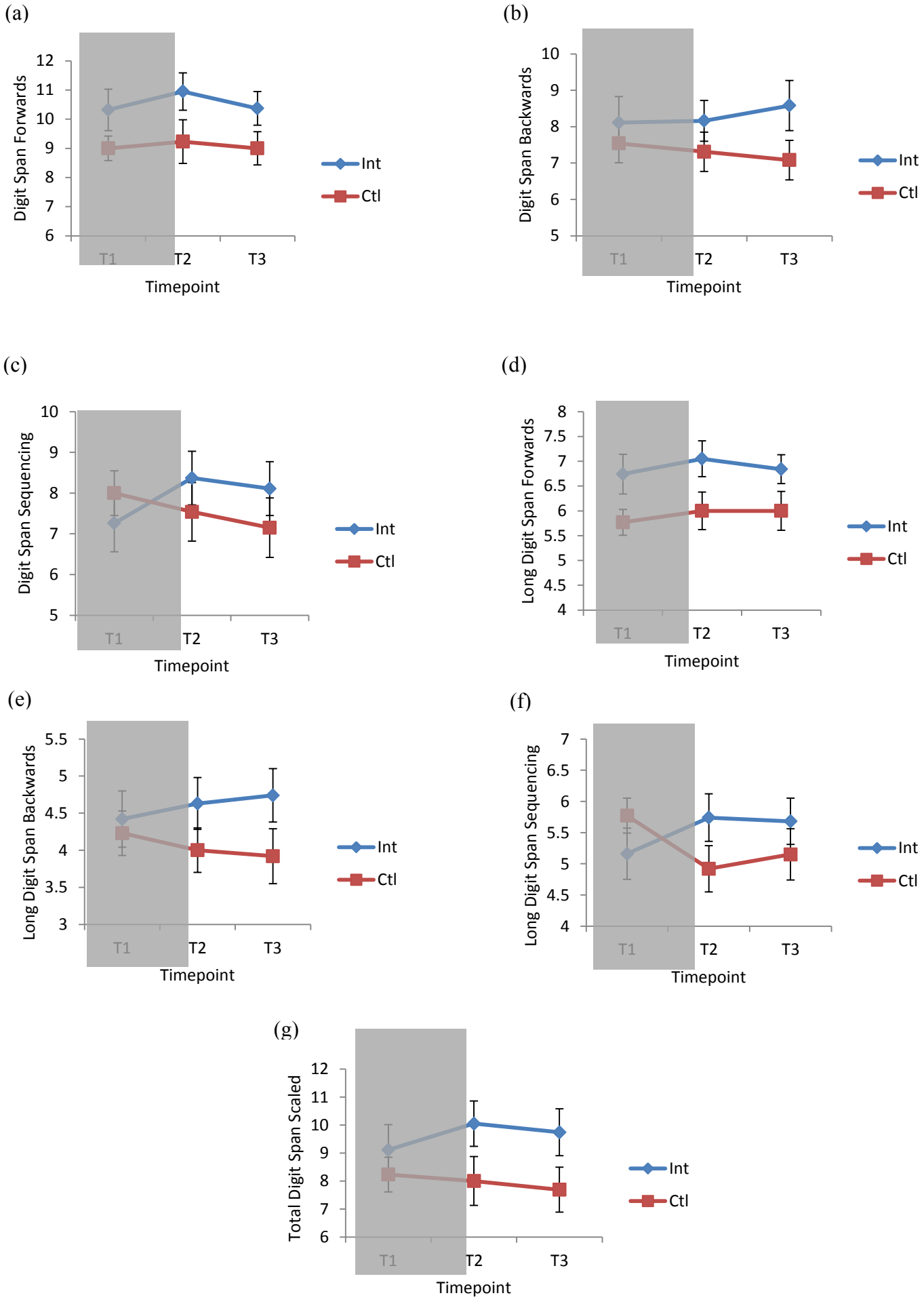


Fig 6.13 *Digit Span results with (a) Digit Span Forwards; (b) Digit Span Backwards; (c) Digit Span Sequencing; (d) Long Digist Span Forwards; (e) Long Digit Span Backwards; (f) Long Digit Span Sequencing; and (g) Total Digit Span Scaled Score for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.17 Hospital Anxiety and Depression Scale: T2 vs T3

Higher scores on Anxiety, Depression and Total Distress subscales indicates higher levels of distress. A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 for the intervention group on Anxiety (Z = -.20, p =.84), Depression (Z = -.86, p =.39) or Total Distress scores (Z = -.66, p =.51), see Table 6.16 and Fig. 6.14. There was no significant difference between T2 and T3 for the control group on Anxiety (Z = -.40, p =.69), Depression (Z = -.53, p =.60) or Total Distress scores (Z = -.41, p =.68), see Table 6.16 and Fig. 6.14.

From a clinical perspective, the mean score for the intervention group on Total Distress decreased from T2 (M12.32) to T3 (M10.95), but remained above normative data levels (9.82) at T3. Similarly, the mean score for the control group decreased slightly from T2 (M14.77) to T3 (M14.23) on this measure, but remained above normative data levels (9.82) at T3. See Table 6.16.

Frequencies of participants in the various categories for anxiety and depression (normal, mild, moderate and severe) were compared between T2 and T3 (see Tables 6.17 and 6.18). For the intervention group, the number of participants in the moderate and severe categories for anxiety reduced from n=4 at T2 to n=2 at T3 and the number of participants falling into the normal range increased from n=12 at T2 to n=14 at T3. The number of intervention participants in the moderate and severe categories for depression increased from n=2 at T2 to n=3 at T3 and the number of participants falling into the normal range increased from n=12 at T2 to n=13 at T3. For the control group, the number of participants in the moderate and severe categories for anxiety stayed the same (n=3) between both timepoints, with two participants moving into the 'severe' category in this group and the number of participants falling into the normal range increasing from n=7 at T2 to n=9 at T3. The number of control group participants in the moderate and severe categories for depression also stayed the same (n=3) between both timepoints, with no participants falling into the 'severe'

category at T3, whereas two participants fell into this category at T2. The number of control group participants in the normal range reduced from *n*=8 at T2 to *n*=6 at T3.

Table 6.16 *Hospital Anxiety and Depression Scale (HADS) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	**Int** *Z*	**Int** *p*	**Control** *Z*	**Control** *p*
Anxiety	*M* 6.21 *SD* 4.72	*M* 7.38 *SD* 4.19	*M* 5.74 *SD* 4.63	*M* 7.08 *SD* 4.72	-.20	.84	-.40	.69
Depression	*M* 6.11 *SD* 4.43	*M* 7.38 *SD* 4.94	*M* 5.21 *SD* 4.65	*M* 7.15 *SD* 4.63	-.86	.39	-.53	.60
Distress	*M* 12.32 *SD* 8.06	*M* 14.77 *SD* 8.18	*M* 10.95 *SD* 8.77	*M* 14.23 *SD* 7.44	-.66	.51	-.41	.68

* p<0.05 ** p<0.01

Table 6.17 *Anxiety at T2and T3: Results by Category (Frequencies)*

	Timepoint 2		**Timepoint 3**	
	Int *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13
Normal	12	7	14	9
Mild	3	3	3	1
Moderate	3	3	1	1
Severe	1	0	1	2

Table 6.18 *Depression at T2and T3: Results by Category (Frequencies)*

	Timepoint 2		**Timepoint 3**	
	Int *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13
Normal	12	8	13	6
Mild	5	2	3	4
Moderate	1	1	2	3
Severe	1	2	1	0

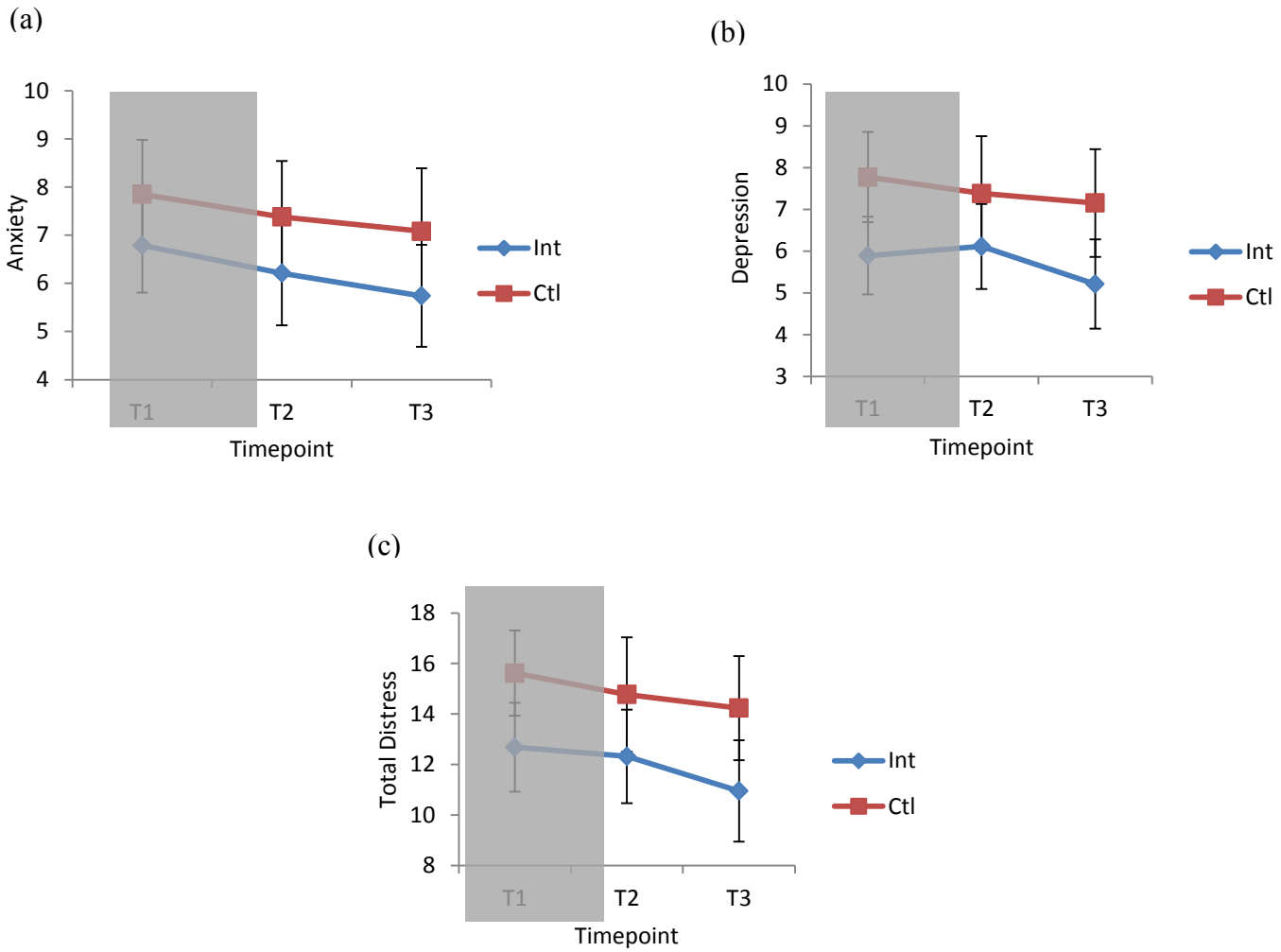


Fig 6.14 *HADS results with (a) Anxiety; (b) Depression; and (c) Distress for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.18 Satisfaction With Life Scale: T2 vs T3

Higher scores on this measure indicate more satisfaction with life. A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 on Satisfaction With Life scores for the intervention group (Z = -.48, p =.64), or the control group (Z = -.51, p =.61), see Table 6.19 and Fig. 6.15.

From a clinical perspective, the mean score for the intervention group on Satisfaction With Life remained at similar levels between T2 (M20.82) and T3 (M20.53), remaining below normative data levels (26.46) at T3. The mean score for the control group decreased

slightly from T2 (*M*18.77) to T3 (*M*17.38) on this measure and remained below normative data levels (26.46) at T3. See Table 6.19.

Table 6.19 *Satisfaction With Life Scale (SWLS) Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int *N*=17	**Control** *N*=13	**Int** *N*=17	**Control** *N*=13	**Int** *Z*	**Int** *p*	**Control** *Z*	**Control** *p*
Satisfaction With Life	*M* 20.82 *SD* 8.34	*M* 18.77 *SD* 8.02	*M* 20.53 *SD* 8.59	*M* 17.38 *SD* 7.97	-.48	.64	-.51	.61

* p<0.05 ** p<0.01

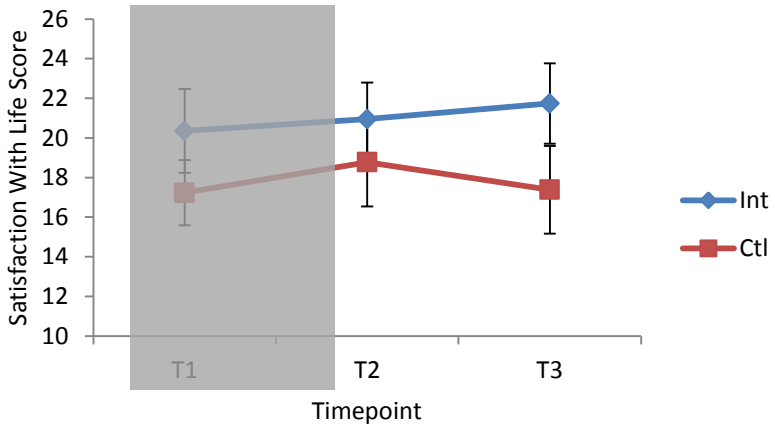


Fig 6.15 *Satisfaction With Life Scale results for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.19 Community Integration Questionnaire: T2 vs T3

Higher scores on all the CIQ subscales and on the total CIQ score indicate better community integration. A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 for the intervention group on Home Integration (Z = -1.81, p =.07), Social Integration (Z = -.24, p =.81), Productivity (Z = -1.72, p =.09) or Total Community Integration (Z = -.05, p =.96), see Table 6.20 and Fig. 6.16.

A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 for the control group on Home Integration (Z = -.12, p =.91), Social Integration (Z = -.30, p =.77), Productivity (Z = -.54, p =.59) or Total Community Integration (Z = -.09, p =.93), see Table 6.20 and Fig. 6.16.

From a clinical perspective, the mean score for the intervention group on Total Community Integration remained at similar levels between T2 (*M*14.13) and T3 (*M*14.32), remaining below normative data levels (19.12) at T3. Similarly, the mean score for the control group remained at similar levels between T2 (*M*15.77) and T3 (*M*15.92), remaining below normative data levels (19.12) at T3. See Table 6.20.

Table 6.20 *Community Integration Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		**Timepoint 3**		**Wilcoxon**		**Wilcoxon**	
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Home Integration	*M* 3.55 *SD* 2.23	*M* 5.23 *SD* 2.97	*M* 4.42 *SD* 2.77	*M* 5.23 *SD* 2.80	-1.81	.07	-.12	.91
Social Integration	*M* 7.21 *SD* 1.75	*M* 7.62 *SD* 3.18	*M* 7.16 *SD* 2.03	*M* 7.69 *SD* 1.93	-.24	.81	-.30	.77
Productivity	*M* 3.37 *SD* 1.71	*M* 2.85 *SD* 1.72	*M* 2.74 *SD* 1.85	*M* 3 *SD* 1.35	-1.72	.09	-.54	.59
Total CIQ Score	*M* 14.13 *SD* 4.23	*M* 15.77 *SD* 5.44	*M* 14.32 *SD* 5.27	*M* 15.92 *SD* 4.01	-.05	.96	-.09	.93

* p<0.05 ** p<0.01

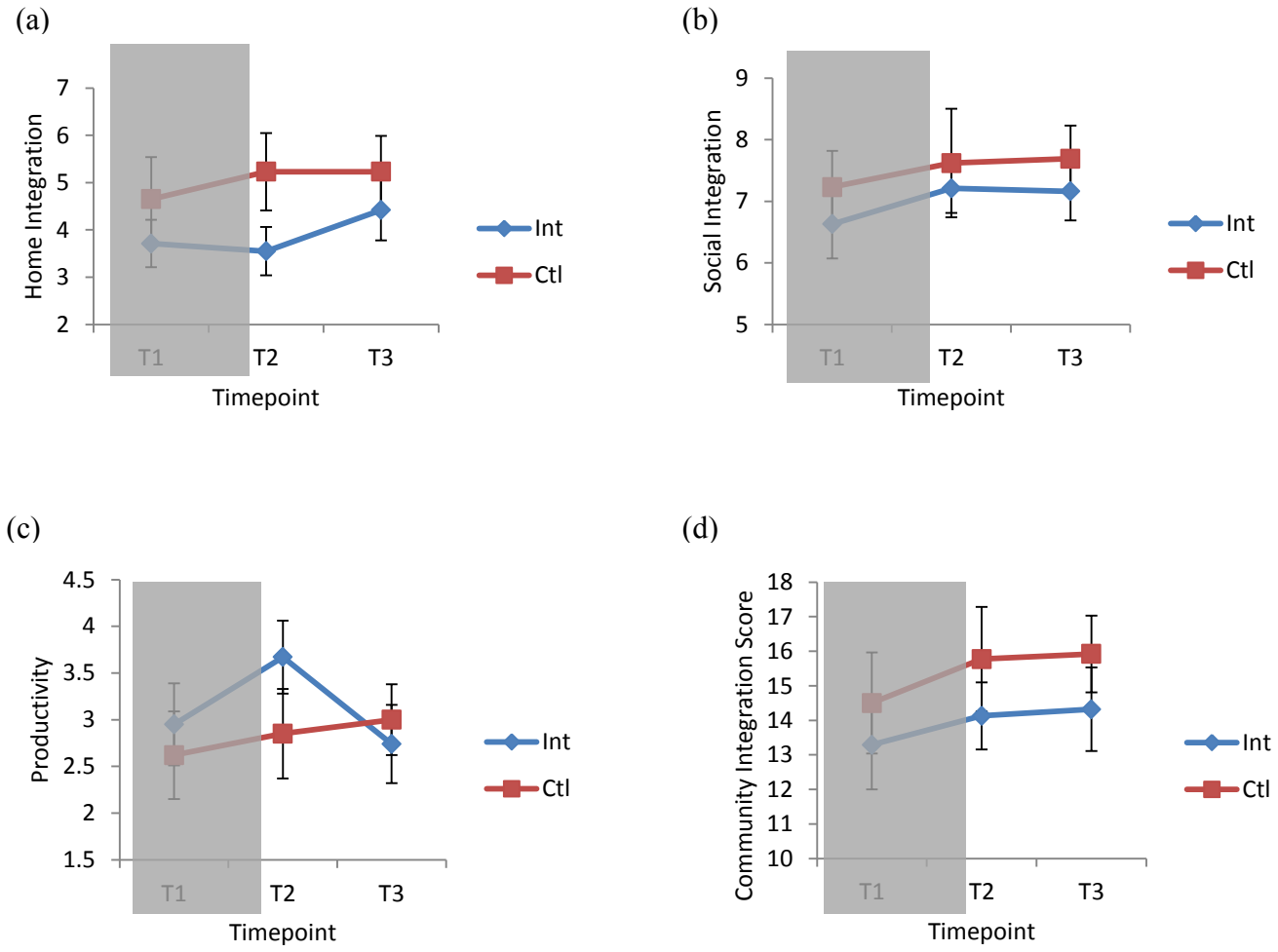


Fig 6.16 *Community Integration Scores with (a) Home Integration; (b) Social Integration; (c) Productivity; and (d) Total CIQ Score for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.20 Cognitive Group Self-Evaluation Questionnaire: T2 vs T3

Higher scores on this measure indicate a more positive rating by a person for their cognitive abilities and how deficits impact on their lives. A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 on Cognitive Group Self Evaluation scores for the intervention group (Z = -.81, p =.42) or the control group (Z = -1.65, p =.1), see Table 6.21 and Fig. 6.17.

Table 6.21 *Cognitive Group Self Evaluation Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		Timepoint 3		Wilcoxon		Wilcoxon	
	Int ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Total CGSE Score	*M* 78.13 *SD* 16.74	*M* 74.38 *SD* 18.58	*M* 82.81 *SD* 20.93	*M* 80.62 *SD* 18.85	-.81	.42	-1.65	.1

* p<0.05 ** p<0.01

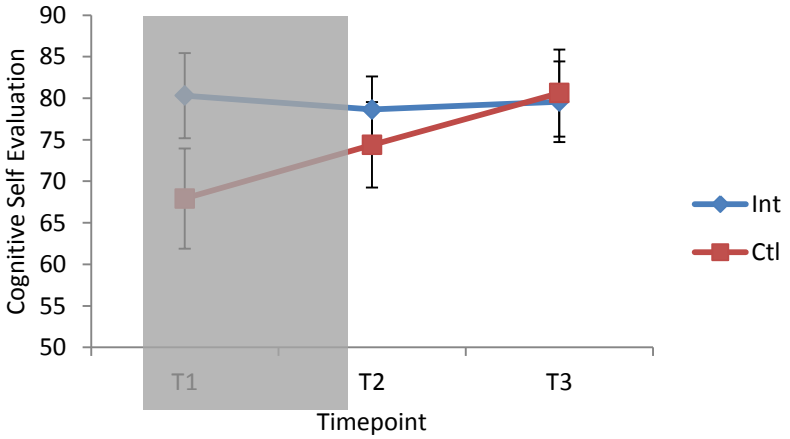


Fig 6.17 *Cognitive Group Self Evaluation Questionnaire Results for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.21 Knowledege of Brain Injury Questionnaire: T2 vs T3

Higher scores on this measure indicate a more positive rating by a person for their knowledge of brain injury.A Wilcoxon Signed Rank Test found no significant difference between T2 and T3 on Knowledge of Brain Injury scores for the intervention group (Z = -.18, p =.86) or the control group (Z = -.28, p =.78), see Table 6.22 and Fig. 6.18.

Table 6.22 *Knowledge of Brain Injury Results (Descriptive Statistics and Wilcoxon Test): Within Group Comparison (T2 v T3)*

	Timepoint 2		Timepoint 3		Wilcoxon		Wilcoxon	
	Int ***N*=18**	**Control** ***N*=12**	**Int** ***N*=18**	**Control** ***N*=12**	**Int** ***Z***	**Int** ***p***	**Control** ***Z***	**Control** ***p***
Knowledge of Brain Injury	*M* 32.67 *SD* 2.72	*M* 33.17 *SD* 3.79	*M* 32.94 *SD* 3.90	*M* 32.67 *SD* 3.80	-.18	.86	-.28	.78

* p<0.05 ** p<0.01

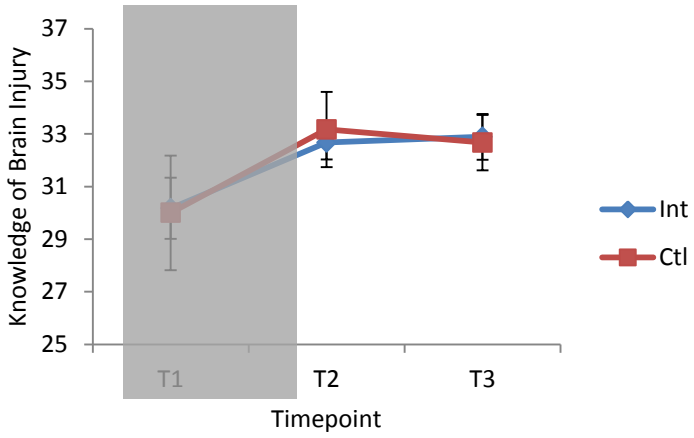


Fig 6.18 *Knowledge of Brain Injury Questionnaire Results for Intervention (Int) and Control (Ctl) groups across timepoints T2 to T3*

6.22 Summary of Significant Effects T2 vs T3

6.22.1 Signifcant Effects for Intervention Group

A Wilcoxon Signed Rank Test showed a significant difference between T2 and T3 for the intervention group on Condition 1 Scaled Score (Z = -2.25, p <.05) and Condition 3 Scaled Score (Z = -2.46, p <.05) of the Trail Making Test, with participants' performance improving between T2 and T3 on both subscales. The intervention group's mean scaled scores for Condition 1 and 3 were closer to normative data levels at T3 when compared to T2 scores, however scores for Condition 1 Scaled Score remained 3.72 points below normative data levels at T3 and scores for Condition 3 Scaled Score remained 2.74 points below normative data levels at T3.

6.22.2 Signifcant Effects for Control Group

A Wilcoxon Signed Rank Test revealed a significant difference between T2 and T3 for the control group on the Learning Slope subscale of the CVLT-II test (Z = -2.07, p <.05), with participants performing significantly better on this measure at T3 than T2.

Chapter 7

Overall Effects Across

Timepoints 1, 2 and 3

7.1 Data Analysis

Data were screened for skewness, kurtosis and to check for outliers. Checks were also made for homogeneity of variance. Within group differences were examined using Friedman Tests and between group differences were examined using Mann-Whitney U Tests, mixed factorial ANOVA and post hoc Bonferroni-corrected t-tests. Within groups factor was timepoint (pre-intervention, post-intervention and 6 months later), and dependent measures were the dependent variables for each of the tests and questionnaires used in the study. SPSS version 22 was used for all statistical analyses.

7.2 California Verbal Learning Test: Overall Effects Across Timepoints 1-3

On the Total Free Recall subscale, a higher score indicates more words recalled, and therefore better performance. On the intrusions and repetitions subscales, a lower z score indicates better performance due to less intrusions or repetitions being made. On the Learning Slope and Semantic Clustering subscales, a higher z score indicates better performance.

7.2.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Total Free Recall T1 [*U*=-.30, p=.76], T2 [*U*=-.33, *p*=.74] or T3 [*U*=-.46, *p*=.65], Intrusions (z score) T1 [*U*=-.96, *p*=.34], T2 [*U*=-.43, *p*=.67] or T3 [*U*=-.29, *p*=.77] or Repetitions (z score) T1 [*U*=-.33, *p*=.74], T2 [*U*=-.80, *p*=.43] or T3[*U*=-.49, *p*=.62] (see Table 7.1 and Fig. 7.1). There was no significant difference between the groups on Learning Slope (z score) T1 [*U*=-.74, *p*=.46], T2 [*U*=-.80, *p*=.43] or T3 scores [*U*=-.58, *p*=.56] or Semantic Clustering (z score) T1 [*U*=-1.24, *p*=.22], T2 [*U*=-.48, *p*=.63] or T3 scores [*U*=-.38, *p*=.70] (see Table 7.1 and Fig. 7.1).

7.2.2. Within Group Comparison (Friedman Tests)

A Friedman test showed a significant difference between the three timepoints on Total Free Recall scores for the intervention group [χ^2 (2)=7.6, p<0.05], with participants showing improved performance between timepoint 1 and timepoint 2, followed by a slight drop in performance at timepoint 3 (see Table 7.2 and Fig. 7.1). No significant difference was observed between the three timepoints on Intrusions (z score) [χ^2 (2)=2.3, *p*=.32], Repetitions (z score) [χ^2 (2)=1.66, *p*=.44], Learning Slope (z score) [χ^2 (2)=3.5, *p*=.17] or Semantic Clustering (z score) [χ^2 (2)=1.23, *p*=.54] for the intervention group (see Table 7.2 and Fig. 7.1).

A Friedman test showed no significant difference between the three timepoints for the control group on Total Free Recall [χ^2 (2)=4.77, *p*=.09], Intrusions (z score) [χ^2 (2)=.05, *p*=.98], Repetitions (z score) [χ^2 (2)=.23, *p*=.89], Learning Slope (z score) [χ^2 (2)=2.98, *p*=.23] or Semantic Clustering (z score) [χ^2 (2)=1, *p*=.61] (see Table 7.2 and Fig. 7.1).

7.2.3. Interaction Effects (Mixed Factorial ANOVA)

There was a significant difference in Total Free Recall scores for the main effect of time [Wilks' Lambda = .75, $F(2, 58) = 5.57$, $p < .05$, multivariate partial eta squared = .16] with both groups showing improved scores between timepoints 1 and 2 and the control group showing improved performance between timepoint 2 and 3 whilst the intervention group's performance disimproved between these two timepoints. A paired samples t-test revealed a significant difference between Timepoints 1 (M = 38, SD = 12.44), and 3 (M = 44.85, SD = 14.35) for the control group on the Total Free Recall Measure (t = -2.75; df = 12; $p < 0.05$, 2-tailed). See Table 7.3 and Fig. 7.1.

The main effect for group [$F(1, 29) = .18$, $p = .67$] and the interaction effect [Wilks' Lambda = .88, $F(2, 58) = 1.44$, $p = .25$] did not reach statistical significance for Total Free

Recall scores. The main effect for group [$F(1, 27) = .02$, $p = .90$], time [Wilks' Lambda = .92, $F(2, 54) = 1.56$, $p = .22$] and the interaction effect [Wilks' Lambda = .94, $F(2, 54) = 1.08$, $p = .35$] did not reach statistical significance for intrusions (z score). The main effect for group [$F(1, 27) = .60$, $p = .44$], time [Wilks' Lambda = .99, $F(2, 54) = .08$, $p = .87$] and the interaction effect [Wilks' Lambda = .99, $F(2, 54) = .02$, $p = .96$] did not reach statistical significance for repetitions (z score). See Table 7.3 and Fig. 7.1.

The main effect for group [$F(1, 28) = .46$, $p = .50$], time [Wilks' Lambda = .89, $F(2, 56) = 1.83$, $p = .17$] and the interaction effect [Wilks' Lambda = .94, $F(2, 56) = .87$, $p = .43$] did not reach statistical significance for the learning slope (z score). The main effect for group [$F(1, 28) = .43$, $p = .52$], time [Wilks' Lambda = 1, $F(2, 56) = .04$, $p = .96$] and the interaction effect [Wilks' Lambda = .92, $F(2, 56) = .85$, $p = .43$] did not reach statistical significance for the semantic clustering (z score). See Table 7.3 and Fig. 7.1.

Table 7.1 *CVLT-II Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**	
	U	***p***	***U***	***p***	***U***	***p***
Total Free Recall (Int *N*=18; Ctl *N*=13)	-.30	.76	-.33	.74	-.46	.65
Intrusions z score (Int *N*=17; Ctl *N*=12)	-.96	.34	-.43	.67	-.29	.77
Repetitions z score (Int *N*=17; Ctl *N*=12)	-.33	.74	-.80	.43	-.49	.62
Learning Slope z score (Int *N*=18; Ctl *N*=12)	-.74	.46	-.80	.43	-.58	.56
Semantic Clustering z score (Int *N*=18; Ctl *N*=12)	-1.24	.22	-.48	.63	-.38	.70

* $p<0.05$ ** $p<0.01$

Table 7.2 *CVLT-II Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		Timepoint 2		Timepoint 3			
	Int	**Control**	**Int**	**Control**	**Int**	**Control**	χ^2 **Int**	χ^2 **Ctrl**
Total Free Recall	*M* 38.18 *SD*15.82 (*N*=18)	*M* 38 *SD*12.44 (*N*=13)	*M* 40.94 *SD*17.43 (*N*=18)	*M* 43.15 *SD*14.38 (*N*=13)	*M* 40.11 *SD*15.29 (*N*=18)	*M* 44.85 *SD*14.35 (*N*=13)	**7.6*** ***p*=.02**	4.77 *p*=.09
Intrusions z score	*M* .41 *SD*1.09 (*N*=17)	*M* .71 *SD*1.03 (*N*=12)	*M* .85 *SD*1.56 (*N*=17)	*M* .88 *SD*1.64 (*N*=12)	*M* 1.29 *SD* 2.06 (*N*=17)	*M* .79 *SD*1.36 (*N*=12)	2.3 *p*=.32	.05 *p*=.98
Repetitions z score	*M* .41 *SD*1.44 (*N*=17)	*M* .21 *SD*1.18 (*N*=12)	*M* .44 *SD*.88 (*N*=17)	*M* .17 *SD*1.11 (*N*=12)	*M* .53 *SD* 1.19 (*N*=17)	*M* .25 *SD*.72 (*N*=12)	1.66 *p*=.44	.23 *p*=.89
Learning Slope z score	*M* -.69 *SD* 1.24 (*N*=18)	*M* -1.17 *SD* 1.42 (*N*=12)	*M* -1.25 *SD* 1.32 (*N*=18)	*M* -1.63 *SD* .93 (*N*=12)	*M* -1.22 *SD* 1.17 (*N*=18)	*M* -1.04 *SD* 1.03 (*N*=12)	3.5 *p*=.17	2.98 *p*=.23
Semantic Clustering z score	*M* -.5 *SD* .62 (*N*=18)	*M* -.29 *SD* .40 (*N*=12)	*M* -.44 *SD* .51 (*N*=18)	*M* -.29 *SD* .58 (*N*=12)	*M* -.36 *SD* .54 (*N*=18)	*M* -.42 *SD* .47 (*N*=12)	1.23 *p*=.54	1 *p*=.61

* $p<0.05$ ** $p<0.01$

Table 7.3 *CVLT-II Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		Timepoint 2		Timepoint 3				
	Int	**Control**	**Int**	**Control**	**Int**	**Control**	**F (time* group)**	**F (time)**	**F (group)**
Total Free Recall	*M* 38.18 *SD*15.82 (*N*=18)	*M* 38 *SD*12.44 (*N*=13)	*M* 40.94 *SD*17.43 (*N*=18)	*M* 43.15 *SD*14.38 (*N*=13)	*M* 40.11 *SD*15.29 (*N*=18)	*M* 44.85 *SD*14.35 (*N*=13)	1.44 *p*=.25	**5.57*** ***p*=.01**	.18 *p*=.67
Intrusions z score	*M* .41 *SD*1.09 (*N*=17)	*M* .71 *SD*1.03 (*N*=12)	*M* .85 *SD*1.56 (*N*=17)	*M* .88 *SD*1.64 (*N*=12)	*M* 1.29 *SD* 2.06 (*N*=17)	*M* .79 *SD*1.36 (*N*=12)	1.08 *p*=.35	1.56 *p*=.22	.02 *p*=.90
Repetitions z score	*M* .41 *SD*1.44 (*N*=17)	*M* .21 *SD*1.18 (*N*=12)	*M* .44 *SD*.88 (*N*=17)	*M* .17 *SD*1.11 (*N*=12)	*M* .53 *SD* 1.19 (*N*=17)	*M* .25 *SD*.72 (*N*=12)	.02 *p*=.96	.087 *p*=.87	.60 *p*=.44
Learning Slope z score	*M* -.69 *SD* 1.24 (*N*=18)	*M* -1.17 *SD* 1.42 (*N*=12)	*M* -1.25 *SD* 1.32 (*N*=18)	*M* -1.63 *SD* .93 (*N*=12)	*M* -1.22 *SD* 1.17 (*N*=18)	*M* -1.04 *SD* 1.03 (*N*=12)	.87 *p*=.43	1.83 *p*=.17	.46 *p*=.50
Semantic Clustering z score	*M* -.5 *SD* .62 (*N*=18)	*M* -.29 *SD* .40 (*N*=12)	*M* -.44 *SD* .51 (*N*=18)	*M* -.29 *SD* .58 (*N*=12)	*M* -.36 *SD* .54 (*N*=18)	*M* -.42 *SD* .47 (*N*=12)	.85 *p*=.43	.04 *p*=.96	.43 *p*=.52

* $p<0.05$ ** $p<0.01$

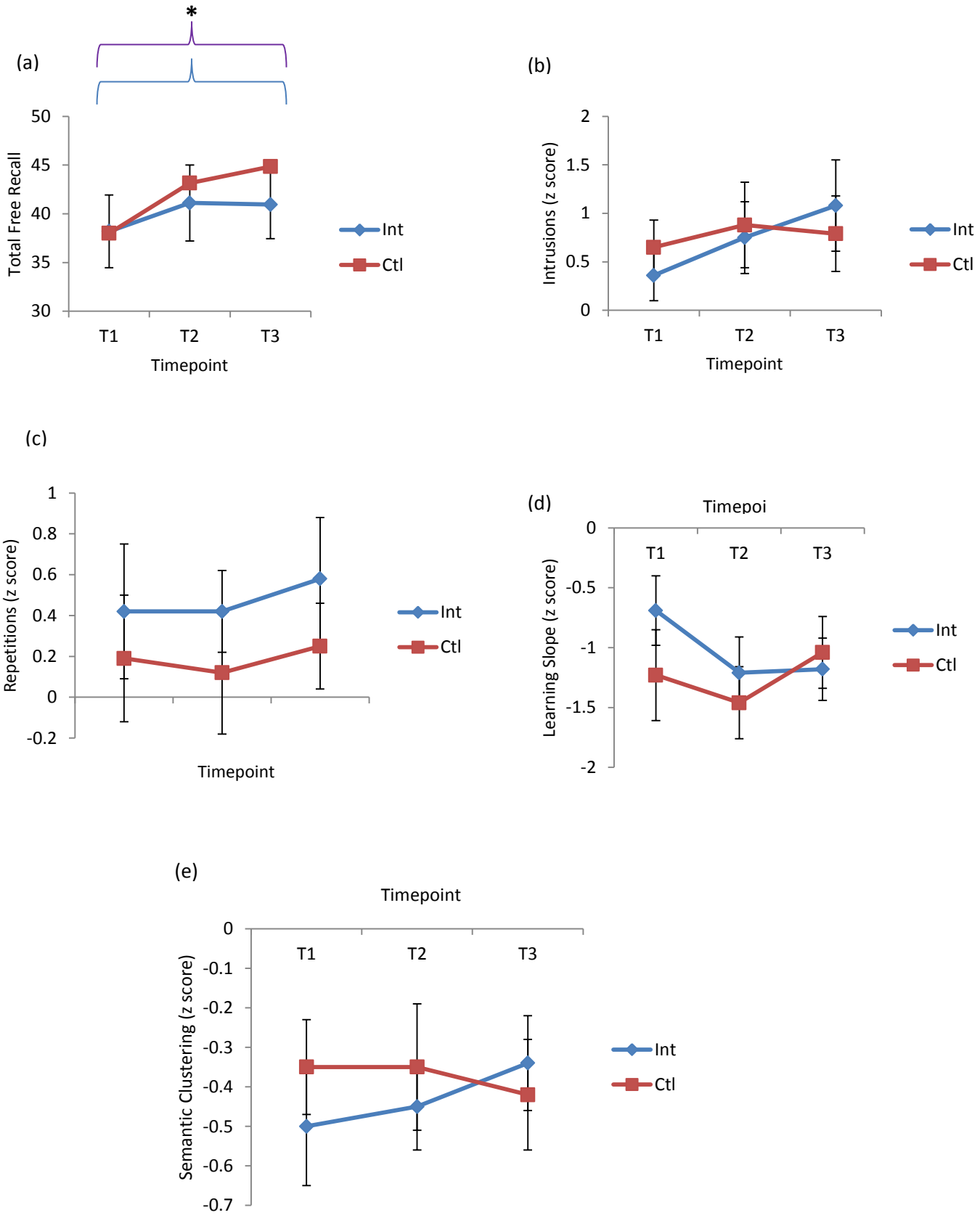


Fig 7.1 *CVLT-II results with (a) Total Free Recall scores; (b) Total Intrusions z score; (c) Total Repetitions z score; (d) Learning Slope z score; and (e) Semantic Clustering z score for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*
Purple bracket indicates significant effect for time

7.3 Trail Making Test: Overall Effects Across Timepoints 1-3

Higher scaled scores on all the Trail Making subscales indicates better performance.

7.3.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Condition 1 Scaled Score T1 [*U*=-.34, *p*=.74], T2 [*U*=-1.08, *p*=.28] or T3 [*U*=-.22, *p*=.83], Condition 2 Scaled Score T1 [*U*=-.06, *p*=.95], T2 [*U*=-.06, *p*=.95] or T3 [*U*=-.70, *p*=.49], Condition 3 Scaled Score T1 [*U*=-.77, *p*=.44], T2 [*U*=-.18, *p*=.86] or T3 [*U*=-.58, *p*=.56], Condition 4 Scaled Score T1 [*U*=-.50, *p*=.62], T2 [*U*=-.51, *p*=.61] or T3 [*U*=-.25, *p*=.8], Condition 5 Scaled Score T1 [*U*=.00, *p*=1], T2 [*U*=-.18, *p*=.86] or T3 [*U*=-.21, *p*=.83] or Condition 4 All Errors Scaled Score T1 [*U*=-.36, *p*=.72], T2 [*U*=-1.63, *p*=.10] or T3 [*U*=-.32, *p*=.75] (see Table 7.4 and Fig.7.2).

7.3.2. Within Group Comparison (Friedman Tests)

A Friedman test revealed a significant difference between the three timepoints on Condition 3 Scaled Score for the intervention group [χ^2 (2)=15.48, *p*<.01] with participants' performance improving at each timepoint (see Table 7.5 and Fig. 7.2), however scores remained below normative data levels at T3. There was no significant difference between the three timepoints on Condition 1 Scaled Score [χ^2 (2)=5.33, *p*=.07], Condition 2 Scaled Score [χ^2 (2)=1.44, *p*=.49], Condition 4 Scaled Score [χ^2 (2)=2.21, *p*=.33], Condition 5 Scaled Score [χ^2 (2)=2.72, *p*=.26] or Condition All Errors Scaled Score [χ^2 (2)=1.77, *p*=.41] for the intervention group (see Table 7.5 and Fig. 7.2).

A Friedman test showed a significant difference between the three timepoints on Condition 4 Scaled Score for the control group [χ^2 (2)=6.53, *p*<.05] with participants' performance improving between timepoint 1 and 2 and then disimproving between timepoint 2 and 3 (see Table 7.5 and Fig. 7.2), remaining below normative data levels at T3. A

Friedman test showed no significant difference between the three timepoints for the control group on Condition 1 Scaled Score [χ^2 (2)=1.5, p=.47], Condition 2 Scaled Score [χ^2 (2)=2.97, p=.23], Condition 3 Scaled Score [χ^2 (2)=.23, p=.89], Condition 5 Scaled Score [χ^2 (2)=3.93, p=.14] or Condition All Errors Scaled Score [χ^2 (2)=3.77, p=.15] (see Table 7.5 and Fig. 7.2).

7.3.3. Between Group Comparison (Mixed Factorial ANOVA)

There was a significant interaction effect on Condition 1 scaled scores (visual scanning) [Wilks' Lambda = .81, F(2, 58) = 4.41, p =.02, multivariate partial eta squared = .13]. The intervention group showed a disimprovement in scores between T1 and T2, followed by an improvement in scores at T3 (but remained below normative data levels) whilst the control group showed the opposite effect, that is their scores improved between T1 and T2 and then disimproved at T3. The main effect for group [F(1, 29) = .22, p =.64] and time [Wilks' Lambda = .97, F(2, 58) = .52, p =.56] did not reach statistical significance for Condition 1 scaled scores. The main effect for group [F(1, 30) = .13, p =.72], time [Wilks' Lambda = .94, F(2, 60) = 1.35, p =.27] and the interaction effect [Wilks' Lambda = .97, F(2, 60) = 1.35, p =.27] did not reach statistical significance for Condition 2 scaled score (number sequencing). See Table 7.6 and Fig. 7.2.

There was a significant difference in Condition 3 scaled scores (letter sequencing) for the main effect of time [Wilks' Lambda = .82, F(2, 60) = 3.70, p =.03, multivariate partial eta squared = .11] and a significant interaction effect [Wilks' Lambda = .82, F(2, 60) = 3.70, p =.03, multivariate partial eta squared = .11] on this measure. The intervention group showed an improvement in performance at each timepoint for this measure whilst the control group showed a disimprovement in scores at each timepoint. There was no significant difference

found on the main effect for group [$F(1, 30) = .02$, $p = .88$] on this measure. See Table 7.6 and Fig. 7.2.

The main effect for group [$F(1, 30) = .03$, $p = .87$], time [Wilks' Lambda = .81, $F(2, 60) = 1.95$, $p = .16$] and the interaction effect [Wilks' Lambda = .89, $F(2, 60) = 1.19$, $p = .31$] did not reach statistical significance for Condition 4 scaled score (number-letter switching). The main effect for group [$F(1, 30) = 1.37$, $p = .25$], time [Wilks' Lambda = .86, $F(2, 60) = 2.12$, $p = .13$] and the interaction effect [Wilks' Lambda = .93, $F(2, 60) = .90$, $p = .41$] did not reach statistical significance for Condition 4 All Errors. See Table 7.6 and Fig. 7.2.

The main effect for group [$F(1, 29) = .05$, $p = .83$], time [Wilks' Lambda = .89, $F(2, 58) = 2.53$, $p = .09$] and the interaction effect [Wilks' Lambda = .98, $F(2, 58) = .51$, $p = .61$] did not reach statistical significance for Condition 5 scaled score (motor speed). See Table 7.6 and Fig. 7.2.

Table 7.4 *Trail Making Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**	
	U	***p***	***U***	***p***	***U***	***p***
Condition 1 (Scaled) (Int *N*=18; Ctl *N*=13)	-.34	.74	-1.08	.28	-.22	.83
Condition 2 (Scaled) (Int *N*=19; Ctl *N*=13)	-.06	.95	-.06	.95	-.70	.49
Condition 3 (Scaled) (Int *N*=19; Ctl *N*=13)	-.77	.44	-.18	.86	-.58	.56
Condition 4 (Scaled) (Int *N*=19; Ctl *N*=13)	-.50	.62	-.51	.61	-.25	.8
Condition 5 (Scaled) (Int *N*=18; Ctl *N*=13)	.00	1	-.18	.86	-.21	.83
Condition 4 All Errors (Scaled) (Int *N*=19; Ctl *N*=13)	-.36	.72	-1.63	.10	-.32	.75

* p<0.05 ** p<0.01

Table 7.5 *Trail Making Results (Descriptive Statistics and Friedman Test):Within Group Comparison*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**			
	Int	**Control**	**Int**	**Control**	**Int**	**Control**	χ^2 **Int**	χ^2 **Ctrl**
Condition 1 (Scaled)	*M* 5.22 *SD*4.24 (*N*=18)	*M* 6.08 *SD*4.46 (*N*=13)	*M* 4.83 *SD*4.11 (*N*=18)	*M* 6.62 *SD*4.19 (*N*=13)	*M* 6.28 *SD*4.34 (*N*=18)	*M* 5.77 *SD*4.60 (*N*=13)	5.33 *p*=.07	1.5 *p*=.47
Condition 2 (Scaled)	*M* 5.95 *SD*3.92 (*N*=19)	*M* 6 *SD*4.20 (*N*=13)	*M* 6.21 *SD*4.34 (*N*=19)	*M* 6.62 *SD*4.03 (*N*=13)	*M* 6.16 *SD*4.13 (*N*=19)	*M* 7.23 *SD*4.44 (*N*=13)	1.44 *p*=.49	2.97 *p*=.23
Condition 3 (Scaled)	*M* 5 *SD*4.43 (*N*=19)	*M* 6.31 *SD*4.44 (*N*=13)	*M* 5.95 *SD*4.89 (*N*=19)	*M* 6.31 *SD*4.42 (*N*=13)	*M* 7.26 *SD*4.68 (*N*=19)	*M* 6.31 *SD*4.82 (*N*=13)	**15.48** *p*=.00**	.23 *p*=.89
Condition 4 (Scaled)	*M* 5.79 *SD*4.60 (*N*=19)	*M* 5.15 *SD*4.20 (*N*=13)	*M* 6.11 *SD*4.63 (*N*=19)	*M* 6.69 *SD*4.50 (*N*=13)	*M* 6.32 *SD*4.28 (*N*=19)	*M* 5.62 *SD*4.61 (*N*=13)	2.21 *p*=.33	**6.53* *p*=.04**
Condition 5 (Scaled)	*M* 6.67 *SD*4.24 (*N*=18)	*M* 6.69 *SD*4.19 (*N*=13)	*M* 6.83 *SD*4.19 (*N*=18)	*M* 7.23 *SD*3.85 (*N*=13)	*M* 7 *SD*4.42 (*N*=18)	*M* 7.54 *SD*3.64 (*N*=13)	2.72 *p*=.26	3.93 *p*=.14
Condition 4 All Errors (Scaled)	*M* 8.05 *SD*4.71 (*N*=19)	*M* 8.77 *SD*3.92 (*N*=13)	*M* 8.11 *SD*4.47 (*N*=19)	*M* 10.31 *SD*3.01 (*N*=13)	*M* 8.74 *SD*4.33 (*N*=19)	*M* 10.31 *SD*1.60 (*N*=13)	1.77 *p*=.41	3.77 *p*=.15

* p<0.05 ** p<0.01

Table 7.6 *Trail Making Results (Mixed Factorial ANOVA):Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**				
	Int	**Control**	**Int**	**Control**	**Int**	**Control**	**F (time* group)**	**F (time)**	**F (group)**
Condition 1 (Scaled)	*M* 5.22 *SD*4.24 (*N*=18)	*M* 6.08 *SD*4.46 (*N*=13)	*M* 4.83 *SD*4.11 (*N*=18)	*M* 6.62 *SD*4.19 (*N*=13)	*M* 6.28 *SD*4.34 (*N*=18)	*M* 5.77 *SD*4.60 (*N*=13)	**3.32* *p*=.02**	.40 *p*=.56	.22 *p*=.64
Condition 2 (Scaled)	*M* 5.95 *SD*3.92 (*N*=19)	*M* 6 *SD*4.20 (*N*=13)	*M* 6.21 *SD*4.34 (*N*=19)	*M* 6.62 *SD*4.03 (*N*=13)	*M* 6.16 *SD*4.13 (*N*=19)	*M* 7.23 *SD*4.44 (*N*=13)	.46 *p*=.48	.95 *p*=.27	.13 *p*=.72
Condition 3 (Scaled)	*M* 5 *SD*4.43 (*N*=19)	*M* 6.31 *SD*4.44 (*N*=13)	*M* 5.95 *SD*4.89 (*N*=19)	*M* 6.31 *SD*4.42 (*N*=13)	*M* 7.26 *SD*4.68 (*N*=19)	*M* 6.31 *SD*4.82 (*N*=13)	**3.24* *p*=.03**	**3.24* *p*=.03**	.02 *p*=.88
Condition 4 (Scaled)	*M* 5.79 *SD*4.60 (*N*=19)	*M* 5.15 *SD*4.20 (*N*=13)	*M* 6.11 *SD*4.63 (*N*=19)	*M* 6.69 *SD*4.50 (*N*=13)	*M* 6.32 *SD*4.28 (*N*=19)	*M* 5.62 *SD*4.61 (*N*=13)	1.84 *p*=.31	3.42 *p*=.16	.03 *p*=.87
Condition 5 (Scaled)	*M* 6.67 *SD*4.24 (*N*=18)	*M* 6.69 *SD*4.19 (*N*=13)	*M* 6.83 *SD*4.19 (*N*=18)	*M* 7.23 *SD*3.85 (*N*=13)	*M* 7 *SD*4.42 (*N*=18)	*M* 7.54 *SD*3.64 (*N*=13)	.35 *p*=.61	1.71 *p*=.09	.05 *p*=.83
Condition 4 All Errors (Scaled)	*M* 8.05 *SD*4.71 (*N*=19)	*M* 8.77 *SD*3.92 (*N*=13)	*M* 8.11 *SD*4.47 (*N*=19)	*M* 10.31 *SD*3.01 (*N*=13)	*M* 8.74 *SD*4.33 (*N*=19)	*M* 10.31 *SD*1.60 (*N*=13)	1.13 *p*=.41	2.32 *p*=.13	1.37 *p*=.25

* p<0.05 ** p<0.01

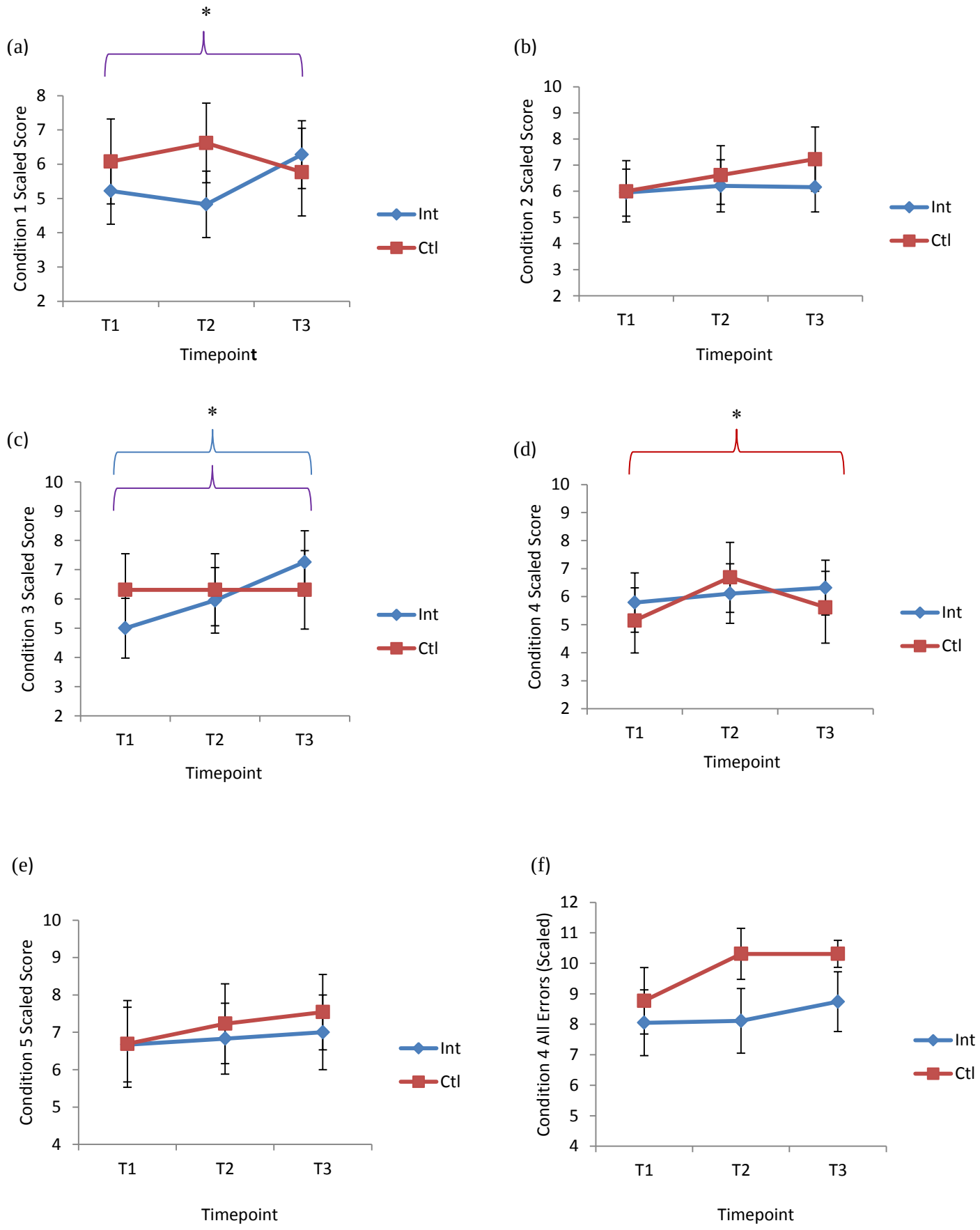


Fig 7.2 *Trail Making Test results with (a) Condition 1 Scaled Score; (b) Condition 2 Scaled Score; (c) Condition 3 Scaled Score; (d) Condition 4 Scaled Score; (e) Condition 5 Scaled Score; and (f) Condition 4 All Errors Scaled Score for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*
Purple bracket indicates significant effect for time/interaction effect

7.4 Sustained Attention Response Task: Overall Effects Across Timepoints 1-3

Higher scores on Total Accuracy and lower scores on Errors of Omission and Errors of Commission indicates better performance on this test. Lower Target Reaction Time scores indicates a faster response to target stimuli and therefore better performance. Lower Reaction Time Error of Commission scores indicates a faster response to clicking the mouse on the number '3' and therefore poorer performance.

7.4.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test showed no significant difference between the intervention and control groups on Total Accuracy T1 [U=-.49, p=.63], T2 [U=-.35, p=.73] or T3 [U=-1.18, p=.24], Error of Omission T1 [U=-.12, p=.90], T2 [U=-.24, p=.81] or T3 [U=-.49, p=.62], Error of Commission T1 [U=-1.14, p=.26], T2 [U=-1.42, p=.15] or T3 [U=-1.32, p=.19], Target Reaction Time T1 [U=-.32, p=.75], T2 [U=-1.14, p=.26] or T3 [U=-.89, p=.37] or Reaction Time Error of Commission T1 [U=-.89, p=.37], T2 [U=-1.30, p=.19] or T3 [U=-.32, p=.75] (see Table 5.7 and Fig. 5.7).

7.4.2. Within Group Comparison (Friedman Tests)

A Friedman test revealed a significant difference between the three timepoints on Total Accuracy scores (calculated as the total number of correct responses to presented stimuli, including inhibition of response to the number 3) for the intervention group [χ^2 (2)=6.27, p<.05] with participants' performance improving at each timepoint (see Table 7.8 and Fig. 7.7). However, see Section 7.5.4 regarding outliers on this measure, which when removed from analysis resulted in no within group significant differences on Total Accuracy scores at T1 for the intervention group.

There was no significant difference between the three timepoints on Error of Omission [χ^2 (2)=2.64, p=.27], Error of Commission [χ^2 (2)=6.17, p=.05], Target Reaction Time [χ^2 (2)=1.15, p=.56] or Reaction Time Error of Commission [χ^2 (2)=1.79, p=.41] scores for the intervention group (see Table 7.8 and Fig. 7.7).

A Friedman test showed no significant difference between the three timepoints on Total Accuracy [χ^2 (2)=3.6, p=.17], Error of Omission [χ^2 (2)=2.3, p=.31], Error of Commission [χ^2 (2)=.96, p=.62], Target Reaction Time [χ^2 (2)=4.67, p=.10] or Reaction Time Error of Commission [χ^2 (2)=3.5, p=.17] scores for the control group (see Table 7.8 and Fig. 7.7).

7.4.3. Between Group Comparison (Mixed Factorial ANOVA)

The main effect for group [F(1, 29) = 1.95, p =.17], time [Wilks' Lambda = .86, F(2, 58) = 3.12, p =.07] and the interaction effect [Wilks' Lambda = .97, F(2, 58) = .63, p =.48] did not reach statistical significance for Total Accuracy scores. The main effect for group [F(1, 29) = .75, p =.40], time [Wilks' Lambda = .93, F(2, 58) = 1.79, p =.18] and the interaction effect [Wilks' Lambda = .94, F(2, 58) = 1.35, p =.26] did not reach statistical significance for Error of Omission scores. See Table 7.9 and Fig. 7.7.

The main effect for group [F(1, 29) = 2.40, p =.13], time [Wilks' Lambda = .92, F(2, 58) = 1.33, p =.27] and the interaction effect [Wilks' Lambda = .95, F(2, 58) = .86, p =.42] did not reach statistical significance for Error of Commission. The main effect for group [F(1, 29) = .47, p =.50], time [Wilks' Lambda = .92, F(2, 58) = 1.26, p =.29] and the interaction effect [Wilks' Lambda = .93, F(2, 58) = 1.09, p =.34] did not reach statistical significance for Target Reaction Time scores. The main effect for group [F(1, 29) = 1.10, p =.30], time [Wilks' Lambda = .91, F(2, 58) = 1.53, p =.23] and the interaction effect [Wilks' Lambda =

.99, $F(2, 58) = .28$, $p = .76$] did not reach statistical significance for Reaction Time Error of Commission scores. See Table 7.9 and Fig. 7.7

Table 7.7 *Sustained Attention Response Task (SART) Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=19; Ctl *N*=12		**Timepoint 2** Int *N*=19; Ctl *N*=12		**Timepoint 3** Int *N*=19; Ctl *N*=12	
	U	***p***	***U***	***p***	***U***	***p***
Total Accuracy	-.49	.63	-.35	.73	-1.18	.24
Error of Omission	-.12	.90	-.24	.81	-.49	.62
Error of Commission	-1.14	.26	-1.42	.15	-1.32	.19
Target Reaction Time	-.32	.75	-1.14	.26	-.89	.37
Reaction Time Error of Commission	-.89	.37	-1.30	.19	-.32	.75

* p<0.05 ** p<0.01

Table 7.8 *Sustained Attention Response Task (SART) Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**			
	Int *N*=19	**Control** *N*=12	**Int** *N*=19	**Control** *N*=12	**Int** *N*=19	**Control** *N*=12	χ^2 **Int**	χ^2 **Ctrl**
Total Accuracy	*M* 200.05 *SD* 14.83	*M* 184.67 *SD* 47.68	*M* 202.79 *SD* 13.15	*M* 195.58 *SD* 25.42	*M* 206.26 *SD* 15.26	*M* 198.92 *SD* 19.30	**6.27*** ***p*=.04**	3.6 *p*=.17
Error of Omission	*M* 14.79 *SD* 13.39	*M* 28 *SD* 44.39	*M* 13.84 *SD* 11.98	*M* 17.50 *SD* 21.8	*M* 13.84 *SD* 18.80	*M* 13.5 *SD* 14.48	2.64 *p*=.27	2.3 *p*=.31
Error of Commission	*M* 10.16 *SD* 5.44	*M* 12.33 *SD* 6.12	*M* 8.26 *SD* 5.30	*M* 11.92 *SD* 6.78	*M* 8.68 *SD* 6.01	*M* 12.58 *SD* 7.53	6.17 *p*=.05	.96 *p*=.62
Target Reaction Time	*M* 420.16 *SD* 85.34	*M* 416.77 *SD* 95.72	*M* 422.56 *SD* 83	*M* 389.06 *SD* 73.03	*M* 415.44 *SD* 98.63	*M* 389.75 *SD* 97.24	1.15 *p*=.56	4.67 *p*=.10
Reaction Time Error of Commission	*M* 195.66 *SD* 104.6	*M* 228.75 *SD* 92.55	*M* 164.01 *SD* 101.69	*M* 210.92 *SD* 95.50	*M* 210.39 *SD*123.61	*M* 228.66 *SD* 88.03	1.79 *p*=.41	3.5 *p*=.17

* p<0.05 ** p<0.01

Table 7.9 *Sustained Attention Response Task (SART) Results (Mixed Factorial ANOVA):Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**				
	Int ***N*=19**	**Control** ***N*=12**	**Int** ***N*=19**	**Control** ***N*=12**	**Int** ***N*=19**	**Control** ***N*=12**	**F (time* group)**	**F (time)**	**F (group)**
Total Accuracy	*M* 200.05 *SD* 14.83	*M* 184.67 *SD* 47.68	*M* 202.79 *SD* 13.15	*M* 195.58 *SD* 25.42	*M* 206.26 *SD* 15.26	*M* 198.92 *SD* 19.30	.63 *p*=.48	3.12 *p*=.07	1.95 *p*=.17
Error of Omission	*M* 14.79 *SD* 13.39	*M* 28 *SD* 44.39	*M* 13.84 *SD* 11.98	*M* 17.50 *SD* 21.8	*M* 13.84 *SD* 18.80	*M* 13.5 *SD* 14.48	1.35 *p*=.26	1.79 *p*=.18	.75 *p*=.40
Error of Commission	*M* 10.16 *SD* 5.44	*M* 12.33 *SD* 6.12	*M* 8.26 *SD* 5.30	*M* 11.92 *SD* 6.78	*M* 8.68 *SD* 6.01	*M* 12.58 *SD* 7.53	.86 *p*=.42	1.33 *p*=.27	2.40 *p*=.13
Target Reaction Time	*M* 420.16 *SD* 85.34	*M* 416.77 *SD* 95.72	*M* 422.56 *SD* 83	*M* 389.06 *SD* 73.03	*M* 415.44 *SD* 98.63	*M* 389.75 *SD* 97.24	1.09 *p*=.34	1.26 *p*=.29	.47 *p*=.5
Reaction Time Error of Commission	*M* 195.66 *SD* 104.6	*M* 228.75 *SD* 92.55	*M* 164.01 *SD* 101.69	*M* 210.92 *SD* 95.50	*M* 210.39 *SD*123.61	*M* 228.66 *SD* 88.03	.28 *p*=.76	1.53 *p*=.23	1.10 *p*=.30

* p<0.05 ** p<0.01

7.4.4. Outliers in Intervention and Control Groups

There is an outlier (reference no. 18) in the control group on Total Accuracy and Error of Omission scores at T1, with this person performing very poorly on these measures at T1, when compared to the other participants in their group. There is also an outlier (reference no. 9) in the intervention group on Error of Omission scores at T1, with this person performing very poorly on this measures at T1 when compared to the other participants in their group.

When the outliers (reference no. 9 and 18) were removed from analysis, parametric (factorial ANOVA) and non-parametric tests (Mann-Whitney U and Friedman tests) revealed no within group or between group significant differences on Total Accuracy and Error of Omission scores at T1 for either group.

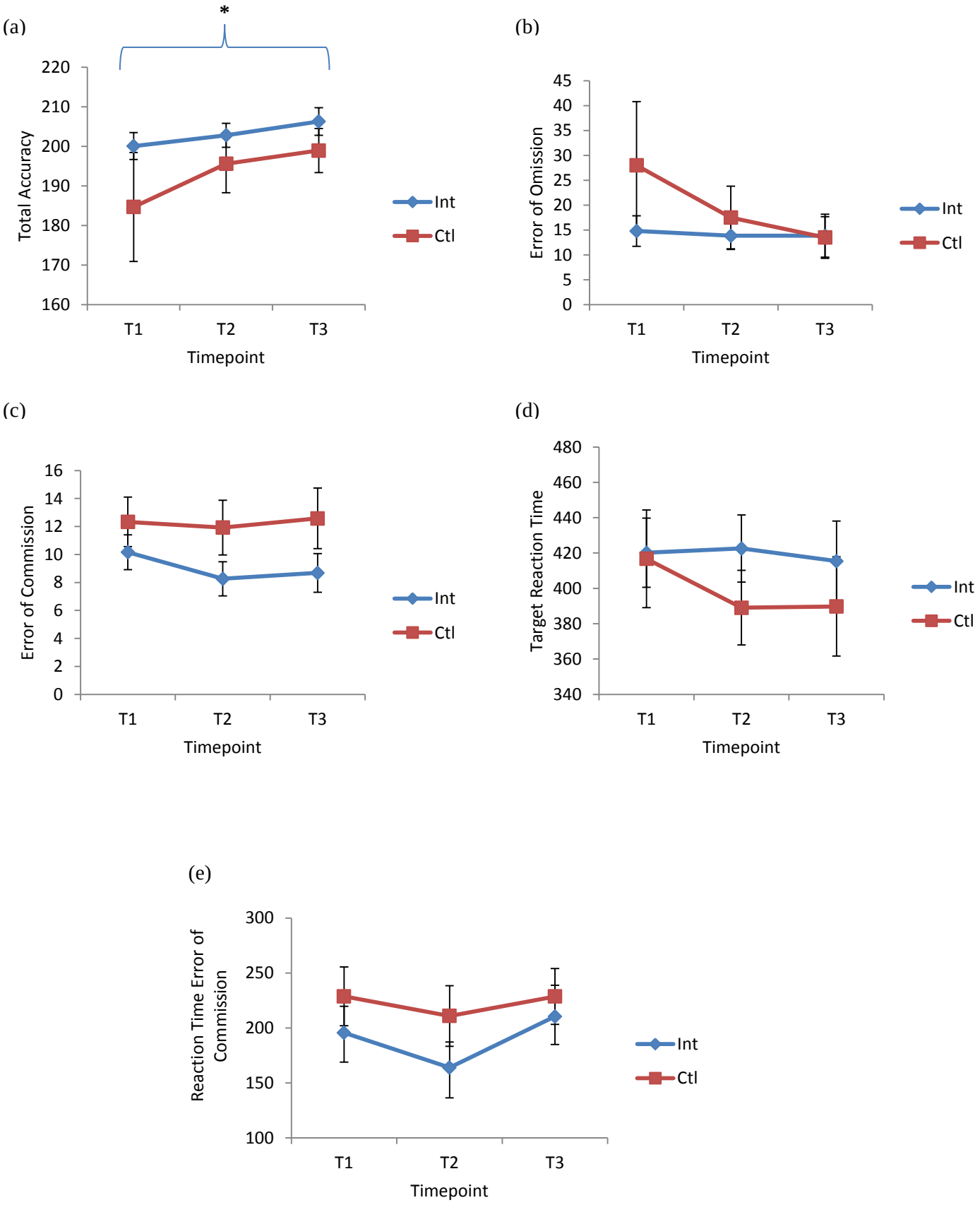


Fig 7.3 *SART Test results with (a) Total Accuracy; (b) Error of Omission; (c) Error of Commission; (d) Target Reaction Time; and (e) Reaction Time Error of Commission for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*

7.5 Digit Span Test: Overall Effects Across Timepoints 1-3

Higher scores on all Digit Span subscales indicates more numbers recalled and therefore better performance.

7.5.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test showed no significant difference between the intervention and control groups on Digit Span Forwards T1 [U=-1.62, p=.11], T2 [U=-1.7, p=.09] or T3 [U=-1.70, p=.09], Digit Span Backwards T1 [U=-.12, p=.91], T2 [U=-.96, p=.34] or T3 [U=-1.5, p=.14] or Digit Span Sequencing T1 [U=-.45, p=.66], T2 [U=-.91, p=.36] or T3 [U=-.79, p=.43] (see Table 7.10 and Fig. 7.4). No significant difference was seen between the two groups on Long Digit Span Forwards T1 [U=-1.88, p=.06], T2 [U=-2, p=.05] or T3 [U=-1.83, p=.07], Long Digit Span Backwards T1 [U=-.10, p=.92], T2 [U=-1.03, p=.30] or T3 [U=-1.60, p=.11], Long Digit Span Sequencing T1 [U=-.80, p=.43], T2 [U=-1.55, p=.12] or T3 [U=-.87, p=.39] or Total Digit Span Scaled T1[U=-.17, p=.86], T2 [U=-1.57, p=.12] or T3 [U=-1.57, p=.12] (see Table 7.10 and Fig. 7.4).

7.5.2. Within Group Comparison (Friedman Tests)

A Friedman test revealed no significant difference between the three timepoints on Digit Span Forwards [χ^2 (2)=3.73, p=.16], Digit Span Backwards [χ^2 (2)=1.26, p=.53] or Digit Span Sequencing [χ^2 (2)=6.03, p=.05] for the intervention group (see Table 7.11 and Fig. 7.4). There was no significant difference seen between the three timepoints on Long Digit Span Forwards [χ^2 (2)=1.4, p=.50], Long Digit Span Backwards [χ^2 (2)=2.44, p=.30] Long Digit Span Sequencing [χ^2 (2)=4.26, p=.12] or Total Digit Span Scaled [χ^2 (2)=4.51, p=.11] for the intervention group (see Table 7.11 and Fig. 7.4).

A Friedman test revealed no significant difference between the three timepoints on Digit Span Forwards [χ^2 (2)=.15, p=.93], Digit Span Backwards [χ^2 (2)=3.66, p=.16] or Digit

Span Sequencing [χ^2 (2)=.37, p=.83] for the control group (see Table 7.11 and Fig. 7.4). There was no significant difference seen between the three timepoints on Long Digit Span Forwards [χ^2 (2)=.56, p=.76], Long Digit Span Backwards [χ^2 (2)=1.23, p=.54] Long Digit Span Sequencing [χ^2 (2)=3.83, p=.15] or Total Digit Span Scaled [χ^2 (2)=1.81, p=.41] for the control group (see Table 7.11 and Fig. 7.4).

7.5.3. Between Group Comparison (Mixed Factorial ANOVA)

The main effect for group [F(1, 30) = 2.91, p =.10], time [Wilks' Lambda = .91, F(2, 60) = 1.43, p =.25] and the interaction effect [Wilks' Lambda = .98, F(2, 60) = .29, p =.75] did not reach statistical significance for Digit Span Forwards scores. The main effect for group [F(1, 30) = 1.38, p =.25], time [Wilks' Lambda = .99, F(2, 60) = .05, p =.95] and the interaction effect [Wilks' Lambda = .95, F(2, 60) = 1.02, p =.37] did not reach statistical significance for Digit Span Backwards scores. The main effect for group [F(1, 30) = .15, p =.70], time [Wilks' Lambda = .96, F(2, 60) = .49, p =.61] and the interaction effect [Wilks' Lambda = .81, F(2, 60) = 3.14, p =.05] did not reach statistical significance for Digit Span Sequencing scores, although the interaction effect was on the threshold of significance (p=.05). See Table 7.12 and Fig. 7.4.

The main effect for group [F(1, 30) = 4.27, p =.05], time [Wilks' Lambda = .94, F(2, 60) = .95, p =.39] and the interaction effect [Wilks' Lambda = .99, F(2, 60) = .14, p =.87] did not reach statistical significance for Long Digit Span Forwards scores, although the main effect for group was on the threshold of significance (p=.05).. The main effect for group [F(1, 30) = 1.45, p =.24], time [Wilks' Lambda = 1, F(2, 60) = .00, p =.10] and the interaction effect [Wilks' Lambda = .94, F(2, 60) = 1.11, p =.34] did not reach statistical significance for Long Digit Span Backwards scores. See Table 7.12 and Fig. 7.4.

There was a statistically significant interaction effect [Wilks' Lambda = .71, $F(2, 60) = 4.46$, $p = .02$, multivariate partial eta squared = .13] observed on the Long Digit Span Sequencing scores, with the intervention group improving between T1 and T2, followed by a slight disimprovement in performance at T3. The control group disimproved between T1 and T2 and improved slightly between T2 and T3. The main effect for group [$F(1, 30) = .27$, $p = .61$] and time [Wilks' Lambda = .99, $F(2, 60) = .15$, $p = .87$] did not reach statistical significance for this measure. See 7.12 and Fig. 7.4.

The main effect for group [$F(1, 30) = 2.05$, $p = .16$], time [Wilks' Lambda = .94, $F(2, 60) = .79$, $p = .46$] and the interaction effect [Wilks' Lambda = .88, $F(2, 60) = 2.40$, $p = .10$] did not reach statistical significance for Total Digit Span Scaled scores. See 7.12 and Fig. 7.4.

Table 7.10 *Digit Span Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=19; Ctl *N*=13		**Timepoint 2 Int *N*=19; Ctl *N*=13**		**Timepoint 3 Int *N*=19; Ctl *N*=13**	
	U	***p***	***U***	***p***	***U***	***p***
Digit Span Forwards	-1.62	.11	-1.7	.09	-1.70	.09
Digit Span Backwards	-.12	.91	-.96	.34	-1.5	.14
Digit Span Sequencing	-.45	.66	-.91	.36	-.79	.43
Long Digit Span Forwards	-1.88	.06	-2.0	.05	-1.83	.07
Long Digit Span Backwards	-.10	.92	-1.03	.30	-1.6	.11
Long Digit Span Sequencing	-.80	.43	-1.55	.12	-.87	.39
Total Digit Span (Scaled)	-.17	.86	-1.57	.12	-157	.12

* p<0.05 ** p<0.01

Table 7.11 *Digit Span Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**			
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	χ^2 **Int**	χ^2 **Ctrl**
Digit Span Forwards	*M* 10.32 *SD* 3.07	*M* 9 *SD* 1.53	*M* 10.95 *SD*2.78	*M* 9.23 *SD* 2.71	*M* 10.37 *SD* 2.52	*M* 9 *SD* 2.04	3.73 *p*=.16	.15 *p*=.93
Digit Span Backwards	*M* 8.11 *SD* 3.13	*M* 7.54 *SD* 1.90	*M* 8.16 *SD* 2.46	*M* 7.31 *SD* 1.93	*M* 4.74 *SD* 1.56	*M* 3.92 *SD* 1.32	1.26 *p*=.53	3.66 *p*=.16
Digit Span Sequencing	*M* 7.26 *SD* 3.07	*M* 8 *SD*2	*M* 8.37 *SD* 2.89	*M* 7.54 *SD*2.60	*M* 8.11 *SD* 2.87	*M* 7.15 *SD* 2.64	6.03 *p*=.05	.37 *p*=.83
Long Digit Span Forwards	*M* 6.74 *SD* 1.76	*M* 5.77 *SD* .93	*M* 7.05 *SD* 1.58	*M* 6 *SD* 1.35	*M* 6.84 *SD* 1.26	*M* 6 *SD* 1.41	1.4 *p*=.50	.56 *p*=.76
Long Digit Span Backwards	*M* 4.42 *SD* 1.68	*M* 4.23 *SD* 1.09	*M* 4.63 *SD* 1.54	*M* 4 *SD* 1.08	*M* 4.74 *SD* 1.56	*M* 3.92 *SD* 1.32	2.44 *p*=.30	1.23 *p*=.54
Long Digit Span Sequencing	*M* 5.16 *SD* 1.80	*M* 5.77 *SD* 1.01	*M* 5.74 *SD* 1.66	*M* 4.92 *SD* 1.32	*M* 5.68 *SD* 1.60	*M* 5.15 *SD* 1.46	4.26 *p*=.12	3.83 *p*=.15
Total Digit Span (Scaled)	*M* 9.11 *SD* 3.91	*M* 8.23 *SD* 2.24	*M* 10.05 *SD* 3.52	*M* 8 *SD* 3.14	*M* 9.74 *SD* 3.66	*M* 7.69 *SD* 2.87	4.51 *p*=.11	1.81 *p*=.41

* p<0.05 ** p<0.01

Table 7.12 *Digit Span Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**				
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**F (time* group)**	**F (time)**	**F (group)**
Digit Span Forwards	*M* 10.32 *SD* 3.07	*M* 9 *SD* 1.53	*M* 10.95 *SD*2.78	*M* 9.23 *SD* 2.71	*M* 10.37 *SD* 2.52	*M* 9 *SD* 2.04	.29 *p*=.75	1.43 *p*=.25	2.91 *p*=.10
Digit Span Backwards	*M* 8.11 *SD* 3.13	*M* 7.54 *SD* 1.90	*M* 8.16 *SD* 2.46	*M* 7.31 *SD* 1.93	*M* 4.74 *SD* 1.56	*M* 3.92 *SD* 1.32	1.02 *p*=.37	.05 *p*=.95	1.38 *p*=.25
Digit Span Sequencing	*M* 7.26 *SD* 3.07	*M* 8 *SD*2	*M* 8.37 *SD* 2.89	*M* 7.54 *SD*2.60	*M* 8.11 *SD* 2.87	*M* 7.15 *SD* 2.64	3.14 *p*=.05	.49 *p*=.61	.15 *p*=.70
Long Digit Span Forwards	*M* 6.74 *SD* 1.76	*M* 5.77 *SD* .93	*M* 7.05 *SD* 1.58	*M* 6 *SD* 1.35	*M* 6.84 *SD* 1.26	*M* 6 *SD* 1.41	.14 *p*=.87	.95 *p*=.39	4.27 *p*=.05
Long Digit Span Backwards	*M* 4.42 *SD* 1.68	*M* 4.23 *SD* 1.09	*M* 4.63 *SD* 1.54	*M* 4 *SD* 1.08	*M* 4.74 *SD* 1.56	*M* 3.92 *SD* 1.32	1.11 *p*=.34	.00 *p*=1	1.45 *p*=.24
Long Digit Span Sequencing	*M* 5.16 *SD* 1.80	*M* 5.77 *SD* 1.01	*M* 5.74 *SD* 1.66	*M* 4.92 *SD* 1.32	*M* 5.68 *SD* 1.60	*M* 5.15 *SD* 1.46	**4.46*** ***p*=.02**	.15 *p*=.87	.27 *p*=.61
Total Digit Span (Scaled)	*M* 9.11 *SD* 3.91	*M* 8.23 *SD* 2.24	*M* 10.05 *SD* 3.52	*M* 8 *SD* 3.14	*M* 9.74 *SD* 3.66	*M* 7.69 *SD* 2.87	2.40 *p*=.10	.79 *p*=.46	2.05 *p*=.16

* p<0.05 ** p<0.01

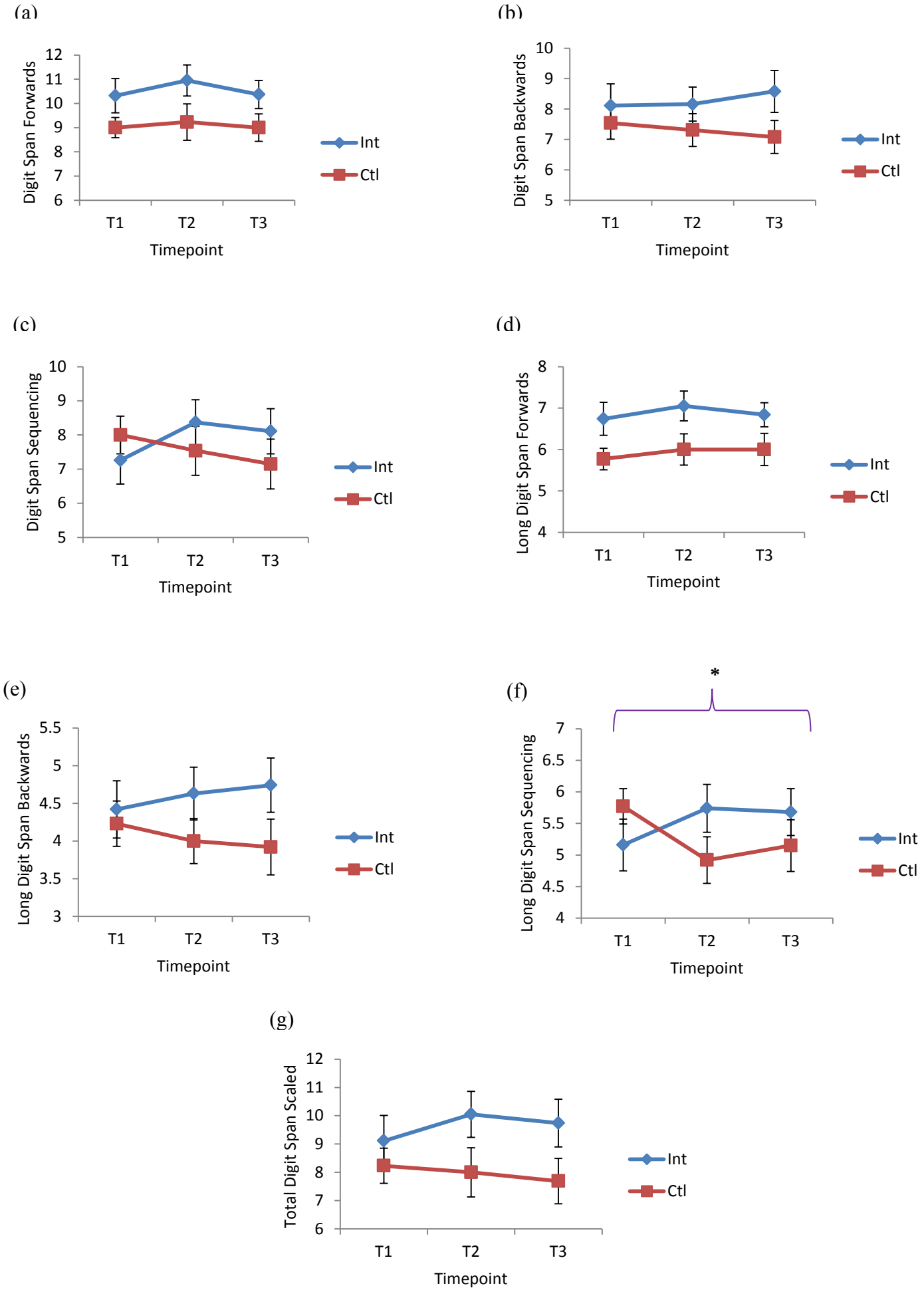


Fig 7.4 *Digit Span results with (a) Digit Span Forwards; (b) Digit Span Backwards; (c) Digit Span Sequencing; (d) Long Digit Span Forwards; (e) Long Digit Span Backwards; (f) Long Digit Span Sequencing; and (g) Total Digit Span Scaled Score for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3. Purple bracket indicates significant interaction effect between the two groups.*

7.6 Hospital Anxiety and Depression Scale: Overall Effects Across Timepoints 1-3

Higher scores on Anxiety, Depression and Total Distress subscales indicates higher levels of distress.

7.6.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Anxiety T1 [U=-.64, p=.52], T2 [U=-.87, p=.39] or T3 [U=-.85, p=.40], Depression T1 [U=-1.27, p=.20], T2 [U=-.66, p=.51] or T3 [U=-1.20, p=.23] or Total Distress T1 [U=-1.33, p=.19], T2 [U=-.79, p=.43] or T3 [U=-1.27, p=.21] (see Table 7.13 and Fig. 7.5).

7.6.2. Within Group Comparison (Friedman Tests)

A Friedman test showed no significant difference between the three timepoints on Anxiety [χ^2 (2)=.60, p=.74] Depression [χ^2 (2)=1.79, p=.41], or Distress [χ^2 (2)=4.62, p=.10] scores for the intervention group (see Table 7.14 and Fig. 7.5). A Friedman test showed no significant difference between the three timepoints on Anxiety [χ^2 (2)=.88, p=.65] Depression [χ^2 (2)=2.5, p=.28], or Distress [χ^2 (2)=1.54, p=.46] scores for the control group (see Table 7.14 and Fig. 7.5).

From a clinical perspective, the intervention group's mean anxiety score reduced to 0.4 points below normative data at T3. The mean score for both groups on Total Distress decreased at each timepoint but remained above normative data levels at T3. (see Table 7.14). For the intervention group, there was a decrease across the three timepoints in the number of participants who were in the moderate and severe anxiety categories, from 5 participants at T1 to 2 participants at T3. There was also a decrease in the number of intervention participants who were in the moderate and severe depression categories, from 4 participants at T1 to 3 participants at T3 (see Tables 7.16 and 7.17). For the control group, the number of

participants in the moderate and severe categories for anxiety and depression remained the same over the three timepoints (*n*=3; see Tables 7.16 and 7.17).

7.6.3. Between Group Comparison (Mixed Factorial ANOVA)

The main effect for group [$F(1, 30) = .70$, $p = .41$], time [Wilks' Lambda = .92, $F(2, 60) = 1$, $p = .37$] and the interaction effect [Wilks' Lambda = .10, $F(2, 60) = .02$, $p = .98$] did not reach statistical significance for Anxiety scores. The main effect for group [$F(1, 30) = 1.47$, $p = .24$], time [Wilks' Lambda = .95, $F(2, 60) = .57$, $p = .57$] and the interaction effect [Wilks' Lambda = .99, $F(2, 60) = .15$, $p = .83$] did not reach statistical significance for Depression scores. The main effect for group [$F(1, 30) = 1.28$, $p = .27$], time [Wilks' Lambda = .89, $F(2, 60) = 1.14$, $p = .33$] and the interaction effect [Wilks' Lambda = .99, $F(2, 60) = .08$, $p = .92$] did not reach statistical significance for Total Distress (anxiety and depression combined) scores. See Table 7.15 and Fig. 7.5.

Table 7.13 *Hospital Anxiety and Depression Scale (HADS) Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=19; Ctl *N*=13		**Timepoint 2 Int *N*=19; Ctl *N*=13**		**Timepoint 3 Int *N*=19; Ctl *N*=13**	
	U	***p***	***U***	***p***	***U***	***p***
Anxiety	-.64	.52	-.87	.39	-.85	.40
Depression	-1.27	.20	-.66	.51	-1.20	.23
Distress	-1.33	.19	-.79	.43	-1.27	.21

* p<0.05 ** p<0.01

Table 7.14 *Hospital Anxiety and Depression Scale (HADS) Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		Timepoint 2		Timepoint 3			
	Int *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	χ^2 **Int**	χ^2 **Ctrl**
Anxiety	*M* 6.79 *SD* 4.26	*M* 7.85 *SD* 4.08	*M* 6.21 *SD* 4.72	*M* 7.38 *SD* 4.19	*M* 5.74 *SD* 4.63	*M* 7.08 *SD* 4.72	.60 *p*=.74	.88 *p*=.65
Depression	*M* 5.89 *SD* 4.07	*M* 7.77 *SD* 3.88	*M* 6.11 *SD* 4.43	*M* 7.38 *SD* 4.94	*M* 5.21 *SD* 4.65	*M* 7.15 *SD* 4.63	1.79 *p*=.41	2.52 *p*=.28
Distress	*M* 12.68 *SD* 7.68	*M* 15.62 *SD* 6.10	*M* 12.32 *SD* 8.06	*M* 14.77 *SD* 8.18	*M* 10.95 *SD* 8.77	*M* 14.23 *SD* 7.44	4.62 *p*=.10	1.54 *p*=.46

* p<0.05 ** p<0.01

Table 7.15 *Hospital Anxiety and Depression Scale (HADS) Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		Timepoint 2		Timepoint 3				
	Int *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	***F*** **(time* group)**	***F*** **(time)**	***F*** **(group)**
Anxiety	*M* 6.79 *SD* 4.26	*M* 7.85 *SD* 4.08	*M* 6.21 *SD* 4.72	*M* 7.38 *SD* 4.19	*M* 5.74 *SD* 4.63	*M* 7.08 *SD* 4.72	.02 *p*=.98	1 *p*=.37	.70 *p*=.41
Depression	*M* 5.89 *SD* 4.07	*M* 7.77 *SD* 3.88	*M* 6.11 *SD* 4.43	*M* 7.38 *SD* 4.94	*M* 5.21 *SD* 4.65	*M* 7.15 *SD* 4.63	.15 *p*=.83	.57 *p*=.57	1.47 *p*=.24
Distress	*M* 12.68 *SD* 7.68	*M* 15.62 *SD* 6.10	*M* 12.32 *SD* 8.06	*M* 14.77 *SD* 8.18	*M* 10.95 *SD* 8.77	*M* 14.23 *SD* 7.44	.08 *p*=.92	1.14 *p*=.33	1.28 *p*=.27

Table 7.16 *Anxiety Results by Category (Frequencies)*

	Timepoint 1		Timepoint 2		Timepoint 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Normal	13	8	12	7	14	9
Mild	1	2	3	3	3	1
Moderate	4	3	3	3	1	1
Severe	1	0	1	0	1	2

Table 7.17 *Depression Results by Category (Frequencies)*

	Timepoint 1		Timepoint 2		Timepoint 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Normal	13	5	12	8	13	6
Mild	2	5	5	2	3	4
Moderate	4	3	1	1	2	3
Severe	0	0	1	2	1	0

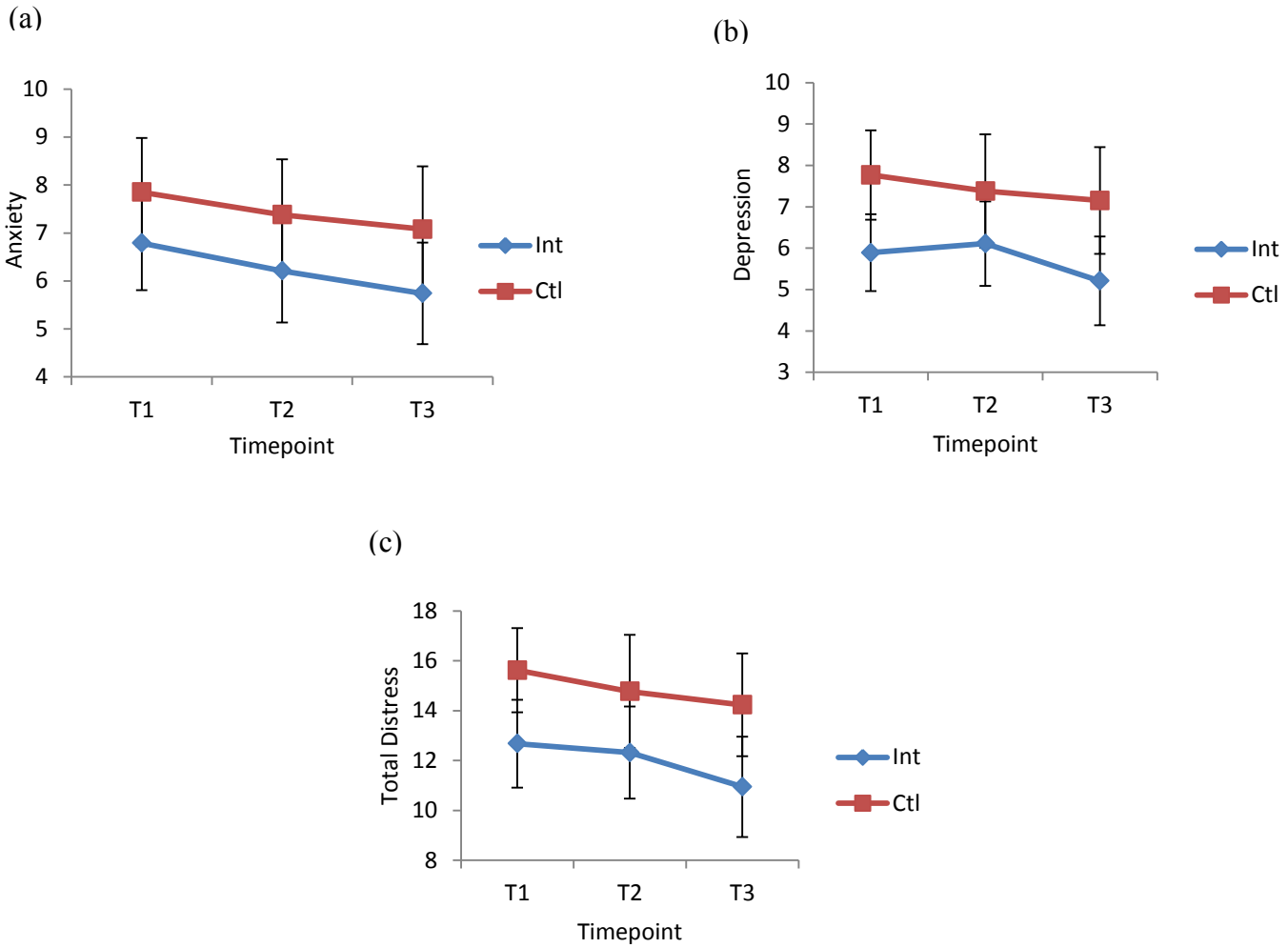


Fig 7.5 *HADS results with (a) Anxiety; (b) Depression; and (c) Distress for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*

7.7 Satisfaction With Life Scale: Overall Effects Across Timepoints 1-3

Higher scores on this measure indicate more satisfaction with life.

7.7.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Satisfaction With Life T1 [*U*=-1.07, *p*=.29], T2 [*U*=-.98, *p*=.33] or T3 [*U*=-1.31, *p*=.19]. See Table 7.18 and Fig. 7.6.

7.7.2. Within Group Comparison (Friedman Tests)

A Friedman test revealed no significant difference between the three timepoints on Satisfaction With Life scores for the intervention group [χ^2 (2)=.22, *p*=.90] or control group [χ^2 (2)=.54, *p*=.76]. See Table Table 7.19 and Fig. 7.6.

From a clinical perspective, the number of intervention group participants who scored in the 'satisfied' or 'highly satisfied' categories increased from *n*=7 at T1 to *n*=9 at T3 and the number of intervention group participants who scored in the 'extremely dissatisfied' or 'dissatisfied' categories stayed the same between T1 and T3 (*n*=4; see Table 7.21). The number of control group participants who scored in the 'satisfied' or 'highly satisfied' categories increased from *n*=2 at T1 to *n*=3 at T3 and the number of control group participants who scored in the 'extremely dissatisfied' or 'dissatisfied' categories increased from *n*=4 at T1 to *n*=7 at T3 (see Table 7.21). Satisfaction With Life mean scores remained below normative data levels at T3 for both intervention and control groups.

7.7.3. Between Group Comparison (Mixed Factorial ANOVA)

The main effect for group [*F*(1, 28) = 1.23, *p* =.28], time [Wilks' Lambda = .97, *F*(2, 56) = .30, *p* =.71] and the interaction effect [Wilks' Lambda = .99, *F*(2, 56) = .10, *p* =.87] did not reach statistical significance for Satisfaction With Life scores. See Table 7.20 and Fig. 7.6.

Table 7.18 *Satisfaction With Life Scale (SWLS) Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=17; Ctl *N*=13		**Timepoint 2 Int *N*=17; Ctl *N*=13**		**Timepoint 3 Int *N*=17; Ctl *N*=13**	
	U	***p***	***U***	***p***	***U***	***p***
Satisfaction With Life	-1.07	.29	-.98	.33	-1.31	.19

* p<0.05 ** p<0.01

Table 7.19 *Satisfaction With Life Scale (SWLS) Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**			
	Int *N*=17	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	χ^2 **Int**	χ^2 **Ctrl**
Satisfaction With Life	*M* 20.35 *SD* 8.75	*M* 17.23 *SD* 5.93	*M* 20.82 *SD* 8.34	*M* 18.77 *SD* 8.02	*M* 20.53 *SD* 8.59	*M* 17.38 *SD* 7.97	.22 *p*=.90	.54 *p*=.76

* p<0.05 ** p<0.01

7.20 *Satisfaction With Life Scale (SWLS) Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**				
	Int *N*=17	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	**Int** *N*=19	**Control** *N*=13	***F (time* group)***	***F (time)***	***F (group)***
Satisfaction With Life	*M* 20.35 *SD* 8.75	*M* 17.23 *SD* 5.93	*M* 20.82 *SD* 8.34	*M* 18.77 *SD* 8.02	*M* 20.53 *SD* 8.59	*M* 17.38 *SD* 7.97	.30 *p*=.87	.10 *p*=.71	1.23 *p*=.28

* p<0.05 ** p<0.01

Table 7.21 *Satisfaction With Life Scale (SWLS) By Category (Frequencies)*

	Timepoint 1 Int *N*=17; Ctl *N*=13		**Timepoint 2 Int *N*=19; Ctl *N*=13**		**Timepoint 3 Int *N*=19; Ctl *N*=13**	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Extremely Dissatisfied	2	1	1	0	2	0
Dissatisfied	2	3	4	5	2	7
Slightly Below Av Satisfied	4	4	4	2	4	2
Average Satisfied	2	3	2	2	2	1
Satisfied	5	2	5	3	4	1
Highly Satisfied	2	0	3	1	5	2

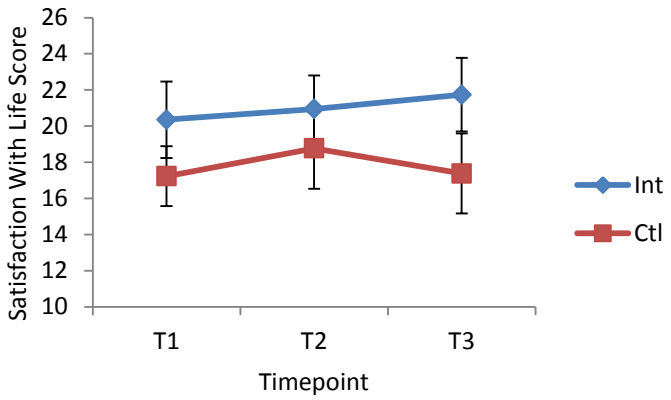


Fig 7.6 *Satisfaction With Life Scale results for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*

7.8 Community Integration Questionnaire: Overall Effects Across Timepoints 1-3

Higher scores on all the CIQ subscales and on the total CIQ score indicate better community integration.

7.8.1. Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Home Integration T1 [U=-.41, p=.68], T2 [U=-1.41, p=.16] or T3 [U=-.73, p=.46], Social Integration T1 [U=-.64, p=.52], T2 [U=-.85, p=.39] or T3 [U=-.72, p=.47], Productivity T1 [U=-.47, p=.64], T2 [U=-.92, p=.36] or T3 [U=-.61, p=.54] or Total Community Integration T1 [U=-.33, p=.74], T2 [U=-.96, p=.34] or T3 [U =-1.08, p=.28]. See Table 7.22 and Fig. 7.7.

7.8.2. Within Group Comparison (Friedman Tests)

A Friedman test showed no significant difference between the three timepoints on Home Integration [χ^2 (2)=2.18, p=.34], Social Integration [χ^2 (2)=3.35, p=.19], Productivity [χ^2 (2)=1, p=.61] or Total Community Integration [χ^2 (2)=.21, p=.90] for the intervention group (see Table 7.23 and Fig. 7.7).

A Friedman test showed no significant difference between the three timepoints on Home Integration [χ^2 (2)=3.19, p=.20], Social Integration [χ^2 (2)=.93, p=.63], Productivity [χ^2 (2)=2.48, p=.29] or Total Community Integration [χ^2 (2)=4.54, p=.10] for the control group (see Table 7.23 and Fig. 7.7).

From a clinical perspective, the mean score for the intervention group on Total Community Integration increased slightly across each timepoint but remained below normative data levels at T3. Similarly, the mean score for the control group increased slightly across each timepoint on this measure, but remained below normative data levels at T3. See Table 7.23.

7.8.3. Between Group Comparison (Mixed Factorial ANOVA)

The main effect for group [F(1, 30) = 1.74, p =.20], time [Wilks' Lambda = .93, F(2, 60) = 1.72, p =.19] and the interaction effect [Wilks' Lambda = .91, F(2, 60) = .87, p =.42] did not reach statistical significance for Home Integration scores. The main effect for group [F(1, 30) = .50, p =.49], time [Wilks' Lambda = .89, F(2, 60) = 1.62, p =.21] and the interaction effect [Wilks' Lambda = 1, F(2, 60) = .05, p =.95] did not reach statistical significance for Social Integration scores. See Table 7.24 and Fig. 7.7.

The main effect for group [F(1, 30) = .14, p =.71], time [Wilks' Lambda = .94, F(2, 60) = .69, p =.51] and the interaction effect [Wilks' Lambda = .92, F(2, 60) = 1.02, p =.37] did not reach statistical significance for Productivity scores. The main effect for group [F(1, 30) = .83, p =.37], time [Wilks' Lambda = .90, F(2, 60) = 1.92, p =.16] and the interaction effect [Wilks' Lambda = 1, F(2, 60) = .06, p =.94] did not reach statistical significance for Community Integration scores. See Table 7.24 and Fig. 7.7.

Table 7.22 *Community Integration Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=19; Ctl *N*=13		**Timepoint 2 Int *N*=19; Ctl *N*=13**		**Timepoint 3 Int *N*=19; Ctl *N*=13**	
	U	***p***	***U***	***p***	***U***	***p***
Home Integration	-.41	.68	-1.41	.16	-.73	.46
Social Integration	-.64	.52	-.85	.39	-.72	.47
Productivity	-.47	.64	-.92	.36	-.61	.54
Total CIQ Score	-.33	.74	-.96	.34	-1.08	.28

* p<0.05 ** p<0.01

Table 7.23 *Community Integration Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**			
	Int *N*=19	**Control *N*=13**	**Int *N*=19**	**Control *N*=13**	**Int *N*=19**	**Control *N*=13**	χ^2 **Int**	χ^2 **Ctrl**
Home Integration	*M* 3.71 *SD* 2.19	*M* 4.65 *SD* 3.21	*M* 3.55 *SD* 2.23	*M* 5.23 *SD* 2.97	*M* 4.42 *SD* 2.77	*M* 5.23 *SD* 2.80	2.18 *p*=.34	3.19 *p*=.20
Social Integration	*M* 6.63 *SD* 2.45	*M* 7.23 *SD* 2.13	*M* 7.21 *SD* 1.75	*M* 7.62 *SD* 3.18	*M* 7.16 *SD* 2.03	*M* 7.69 *SD* 1.93	3.35 *p*=.19	.93 *p*=.63
Productivity	*M* 2.95 *SD* 1.93	*M* 2.62 *SD* 1.71	*M* 3.37 *SD* 1.71	*M* 2.85 *SD* 1.72	*M* 2.74 *SD* 1.85	*M* 3 *SD* 1.35	1 *p*=.61	2.48 *p*=.29
Total CIQ Score	*M* 13.29 *SD* 5.63	*M* 14.5 *SD* 5.27	*M* 14.13 *SD* 4.23	*M* 15.77 *SD* 5.44	*M* 14.32 *SD* 5.27	*M* 15.92 *SD* 4.01	.21 *p*=.90	4.54 *p*=.10

* p<0.05 ** p<0.01

7.24 *Community Integration Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**				
	Int ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	**Int** ***N*=19**	**Control** ***N*=13**	***F*** **(time* group)**	***F*** **(time)**	***F*** **(group)**
Home Integration	*M* 3.71 *SD* 2.19	*M* 4.65 *SD* 3.21	*M* 3.55 *SD* 2.23	*M* 5.23 *SD* 2.97	*M* 4.42 *SD* 2.77	*M* 5.23 *SD* 2.80	.87 *p*=.42	1.72 *p*=.19	1.74 *p*=.20
Social Integration	*M* 6.63 *SD* 2.45	*M* 7.23 *SD* 2.13	*M* 7.21 *SD* 1.75	*M* 7.62 *SD* 3.18	*M* 7.16 *SD* 2.03	*M* 7.69 *SD* 1.93	.05 *p*=.95	1.62 *p*=.21	.50 *p*=.49
Productivity	*M* 2.95 *SD* 1.93	*M* 2.62 *SD* 1.71	*M* 3.37 *SD* 1.71	*M* 2.85 *SD* 1.72	*M* 2.74 *SD* 1.85	*M* 3 *SD* 1.35	1.02 *p*=.37	.69 *p*=.51	.14 *p*=.71
Total CIQ Score	*M* 13.29 *SD* 5.63	*M* 14.5 *SD* 5.27	*M* 14.13 *SD* 4.23	*M* 15.77 *SD* 5.44	*M* 14.32 *SD* 5.27	*M* 15.92 *SD* 4.01	.06 *p*=.94	1.92 *p*=.16	.83 *p*=.37

* $p<0.05$ ** $p<0.01$

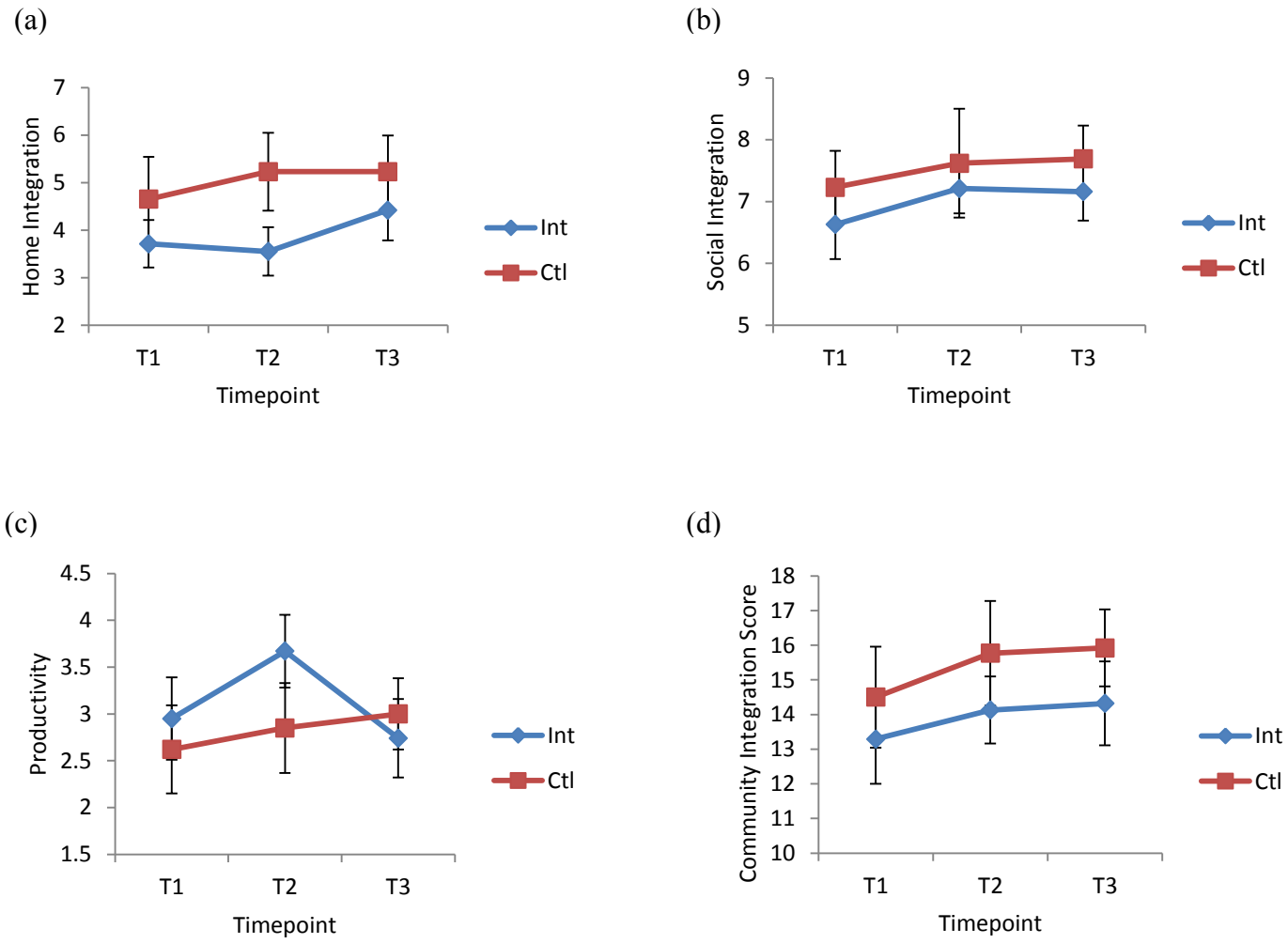


Fig 7.7 *Community Integration Scores with (a) Home Integration; (b) Social Integration; (c) Productivity; and (d) Total CIQ Score for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*

7.9 Cognitive Group Self-Evaluation Questionnaire: Overall Effects Across Timepoints 1-3

Higher scores on this measure indicate a more positive rating by a person for their cognitive abilities and how deficits impact on their lives.

7.9.1 Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test revealed no significant difference between the intervention and control groups on Cognitive Group Self Evaluation T1 [*U*=-1.49, *p*=.14], T2 [*U*=-.44, *p*=.66] or T3 [*U*=-.08, *p*=.94] (see Table 7.25 and Fig. 7.8).

7.9.2. Within Group Comparison (Friedman Tests)

A Friedman test revealed no significant difference between the three timepoints on Cognitive Group Self Evaluation scores for the intervention group [χ^2 (2)=.88, *p*=.65] or control group [χ^2 (2)=4.32, *p*=.12] (see Table 7.26 and Fig. 7.8).

7.9.3. Between Group Comparison (Mixed Factorial ANOVA)

The main effect for group [*F*(1, 27) = .96, *p* =.34], time [Wilks' Lambda = .76, *F*(2, 54) = 2.81, *p* =.08] and the interaction effect [Wilks' Lambda = .92, *F*(2, 54) = 1.38, *p* =.26] did not reach statistical significance for Cognitive Group Self Evaluation scores. See Table 7.27 and Fig. 7.8.

Table 7.25 *Cognitive Group Self Evaluation Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=16; Ctl *N*=13		**Timepoint 2 Int *N*=16; Ctl *N*=13**		**Timepoint 3 Int *N*=16; Ctl *N*=13**	
	U	***p***	***U***	***p***	***U***	***p***
Total CGSE Score	-1.49	.14	-.44	.66	-.08	.94

* p<0.05 ** p<0.01

Table 7.26 *Cognitive Group Self Evaluation Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		Timepoint 2		Timepoint 3			
	Int ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	χ^2 **Int**	χ^2 **Ctrl**
Total CGSE Score	*M* 80.31 *SD* 20.51	*M* 67.92 *SD* 21.74	*M* 78.13 *SD* 16.74	*M* 74.38 *SD* 18.58	*M* 82.81 *SD* 20.93	*M* 80.62 *SD* 18.85	.88 *p*=.65	4.32 *p*=.12

* p<0.05 ** p<0.01

7.27 *Cognitive Group Self Evaluation Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		Timepoint 2		Timepoint 3				
	Int ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	**Int** ***N*=16**	**Control** ***N*=13**	***F* (time* group)**	***F* (time)**	***F* (group)**
Total CGSE Score	*M* 80.31 *SD* 20.51	*M* 67.92 *SD* 21.74	*M* 78.13 *SD* 16.74	*M* 74.38 *SD* 18.58	*M* 82.81 *SD* 20.93	*M* 80.62 *SD* 18.85	1.38 *p*=.26	2.81 *p*=.08	.96 *p*=.34

* p<0.05 ** p<0.01

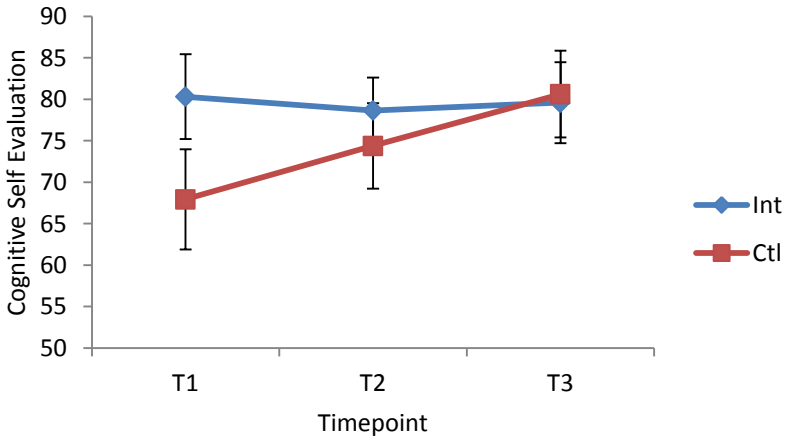


Fig 7.8 *Cognitive Group Self Evaluation Questionnaire Results for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*

7.10 Knowledege of Brain Injury Questionnaire: Overall Effects Across Timepoints 1-3

A higher score on this questionnaire indicates increased knowledge of brain injury.

7.10.1 Between Group Comparison (Mann-Whitney U Tests)

A Mann-Whitney U test showed no significant difference between the intervention and control groups on Knowledge of Brain Injury T1 [U=-.28, p=.78], T2 [U=-.08, p=.94] or T3 [U=-.15, p=.88] (see Table 7.28 and Fig. 7.9).

7.10.2 Within Group Comparison (Friedman Tests)

A Friedman test showed no significant difference between the three timepoints on Knowledge of Brain Injury scores for the intervention group [χ^2 (2)=2.63, p=.27] or the control group [χ^2 (2)=.39, p=.82] (see Table 7.29 and Fig. 7.9).

7.10.3. Between Group Comparison (Mixed Factorial ANOVA)

There was a significant difference in Knowledge of Brain Injury scores for the main effect of time [Wilks' Lambda = .86, F(2, 56) = 3.92, p =.04, multivariate partial eta squared = .12] (See Table 7.30 and Fig. 7.9). Scores for the intervention group increased on this measure at each timepoint whereas scores for the control group increased between T1 and T2 and then decreased slightly at T3. The main effect for group [F(1, 28) = .00, p =.99] and the interaction effect [Wilks' Lambda = .99, F(2, 56) = .07, p =.87] did not reach statistical significance for Knowledge of Brain Injury scores (see Table 7.30 and Fig. 7.9).

Table 7.28 *Knowledge of Brain Injury Results (Mann-Whitney U Test): Comparison Between Intervention and Control Groups*

	Timepoint 1 Int *N*=18; Ctl *N*=12		**Timepoint 2 Int *N*=18; Ctl *N*=12**		**Timepoint 3 Int *N*=18; Ctl *N*=12**	
	U	***p***	***U***	***p***	***U***	***p***
Knowledge of Brain Injury	-.28	.78	-.08	.94	-.15	.88

* p<0.05 ** p<0.01

Table 7.29 *Knowledge of Brain Injury Results (Descriptive Statistics and Friedman Test): Within Group Comparison*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**			
	Int *N*=18	**Control *N*=12**	**Int *N*=18**	**Control *N*=12**	**Int *N*=18**	**Control *N*=12**	χ^2 **Int**	χ^2 **Ctrl**
Knowledge of Brain Injury	*M* 30.17 *SD* 4.93	*M* 30 *SD* 7.54	*M* 32.67 *SD* 2.72	*M* 33.17 *SD* 3.79	*M* 32.94 *SD* 3.90	*M* 32.67 *SD* 3.80	2.63 *p*=.27	.39 *p*=.82

* p<0.05 ** p<0.01

7.30 *Knowledge of Brain Injury Results (Mixed Factorial ANOVA): Comparison Between Intervention and Control Groups*

	Timepoint 1		**Timepoint 2**		**Timepoint 3**				
	Int *N*=18	**Control *N*=12**	**Int *N*=18**	**Control *N*=12**	**Int *N*=18**	**Control *N*=12**	***F* (time* group)**	***F* (time)**	***F* (group)**
Knowledge of Brain Injury	*M* 30.17 *SD* 4.93	*M* 30 *SD* 7.54	*M* 32.67 *SD* 2.72	*M* 33.17 *SD* 3.79	*M* 32.94 *SD* 3.90	*M* 32.67 *SD* 3.80	.07 *p*=.87	**3.92* *p*=.04**	.00 *p*=.99

* p<0.05 ** p<0.01

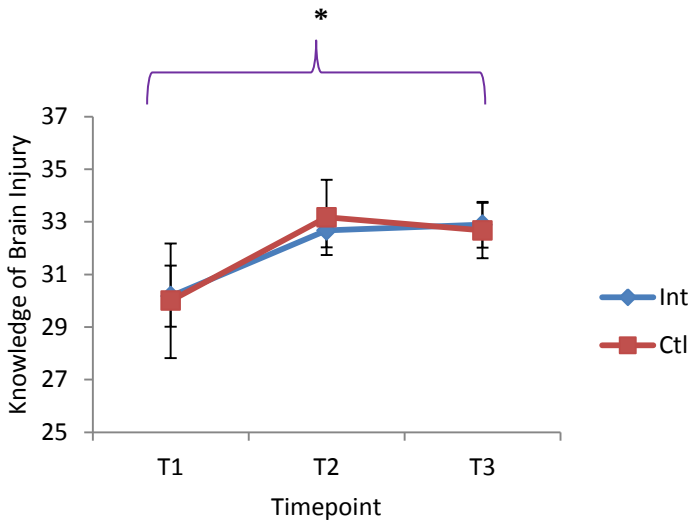


Fig 7.9 *Knowledge of Brain Injury Questionnaire Results for Intervention (Int) and Control (Ctl) groups across Timepoints T1 to T3*

7.11 Summary of Significant Effects

7.11.1 Signifcant Effects for Intervention Group

A Friedman test showed a significant difference between the three timepoints on the Total Free Recall subscale of the CVLT-II test for the intervention group [χ^2 (2)=7.6, p<.05], with participants showing improved performance between timepoint 1 and timepoint 2, followed by a slight drop in performance at timepoint 3. A Friedman test revealed a significant difference between the three timepoints on Condition 3 Scaled Score of the Trail Making Test for the intervention group [χ^2 (2)=15.48, p<.01] with participants' performance improving at each timepoint.

On the SART test, a Friedman test revealed a significant difference between the three timepoints on Total Accuracy scores for the intervention group [χ^2 (2)=6.27, p<.05] with participants' performance improving at each timepoint.

7.11.2 Signifcant Effects for Control Group

A Friedman test showed a significant difference between the three timepoints on Condition 4 Scaled Score of the Trail Making Test for the control group [χ^2 (2)=6.53, p<.05] with participants' performance improving between timepoint 1 and 2 and then disimproving between timepoint 2 and 3.

7.11.3 Signifcant Time, Group and Interaction Effects (ANOVA and t-tests)

There was a significant difference in Total Free Recall scores (CVLT-II test) for the main effect of time [Wilks' Lambda = .75, F(2, 58) = 5.57, p <.05, multivariate partial eta squared = .16] with both groups showing improved scores between timepoints 1 and 2 and the control group showing improved performance between timepoint 2 and 3 whilst the intervention group's performance disimproved between these two timepoints. A paired samples t-test revealed a significant difference between Timepoints 1 (M = 38, SD = 12.44), and 3 (M = 44.85, SD = 14.35) for the control group on the Total Free Recall Measure (t = -2.75; df = 12; p < 0.05, 2-tailed).

On the Trail Making test, there was a significant interaction effect on Condition 1 scaled scores (visual scanning) [Wilks' Lambda = .81, F(2, 58) = 4.41, p =.02, multivariate partial eta squared = .13]. The intervention group showed a disimprovement in scores between T1 and T2, followed by an improvement in scores at T3 (but remained below normative data levels) whilst the control group showed the opposite effect, that is their scores improved between T1 and T2 and then disimproved at T3.

There was a significant difference in Condition 3 scaled scores (letter sequencing) for the main effect of time [Wilks' Lambda = .82, F(2, 60) = 3.70, p =.03, multivariate partial eta squared = .11] and a significant interaction effect [Wilks' Lambda = .82, F(2, 60) = 3.70, p =.03, multivariate partial eta squared = .11] on this measure. The intervention group showed

an improvement in performance at each timepoint for this measure whilst the control group showed a disimprovement in scores at each timepoint.

There was a statistically significant interaction effect [Wilks' Lambda = .71, $F(2, 60) = 4.46$, $p = .02$, multivariate partial eta squared = .13] observed on the Long Digit Span Sequencing scores, with the intervention group improving between T1 and T2, followed by a slight disimprovement in performance at T3. The control group disimproved between T1 and T2 and improved slightly between T2 and T3.

There was a significant difference in Knowledge of Brain Injury scores for the main effect of time [Wilks' Lambda = .86, $F(2, 37.79) = 3.92$, $p = .04$, multivariate partial eta squared = .12] (See Table 7.30 and Fig. 7.9). Scores for the intervention group increased on this measure at each timepoint whereas scores for the control group increased between T1 and T2 and then decreased slightly at T3.

Chapter 8

Correlation Analysis

8.1 Correlation Analysis

Correlation analysis was conducted on the main dependent variables and the continuous demographic variables of age, time since injury and years of education. Correlation analysis was also conducted on the main dependent variables for neuropsychological measures (including the Cognitive Self Evaluation measure) and the mood variables of anxiety, depression and distress (anxiety and depression combined). In order to control for type 1 errors, a significance level of $p<.01$ was used. In advance of conducting the correlation analysis, scatterplots were prepared to check for violation of the assumptions of linearity and homoscedasticity and to check for outliers (see Fig. 8.1 – Fig. 8.6 for scatterplots where there were significant associations). Where there was no violation, Pearson's correlation test was used and where there was violation, Spearman's rho test was used. Outliers were found on SART Total Accuracy and Error of Omission scores at T1 and therefore correlation analysis was run with these outliers and then without the outliers included. Results are shown in Tables 8.1 - 8.10.

8.1.1 Significant Associations (California Verbal Learning Test)

A Spearman's rho correlation revealed a large significant negative correlation between participants' Semantic Clustering z scores and age ($r=-.519$; $p<.01$, 2-tailed) at timepoint 2, indicating that younger participants performed better in relation to semantic clustering, which is seen as an effective strategy for learning unstructured verbal information.

8.1.2 Significant Associations (Trail Making Test)

A Spearman's rho correlation revealed a large significant negative correlation at timepoint 3 between participants' time since injury and Condition 3 Scaled Score ($r=-.54$; $p<.01$, 2-tailed) and Condition 4 Scaled Score ($r=-.64$; $p<.01$, 2-tailed). These results indicate that participants

performed better on elements of the Trail Making test at T3, where less time had elapsed since their brain injury.

8.1.3 Significant Associations (Digit Span Test)

A Spearman's rho correlation showed a strong significant negative correlation between participants' Digit Span Sequencing score and time since injury (r=-.539; p<.01, 2-tailed) at timepoint 1. This result indicates that participants with more recent injuries performed better on Digit Span Sequencing at T1.

8.1.4 Significant Associations (Hospital Anxiety and Depression Scale)

A Pearson's correlation found a large significant negative correlation between participants' anxiety levels and Cognitive Self-Evaluation scores at timepoint 1 (r=-.607; p<.01, 2-tailed) and a Spearman's rho correlation showed a large significant negative correlation between these measures at timepoint 2 (r=-.608; p<.01, 2-tailed) and timepoint 3 (r=-.514; p<.01, 2-tailed). This indicates that participants who were experiencing higher anxiety levels evaluated themselves lower in relation to cognition and the impact of cognitive deficits on their lives, at all three timepoints.

A Spearman's rho correlation showed a large significant negative correlation between participants' Cognitive Group Self Evaluation scores and depression at timepoint 1 (r=-.611; p<.01, 2-tailed), timepoint 2 (r=-.544; p<.01, 2-tailed) and timepoint 3 (r=-.525; p<.01, 2-tailed). This indicates that participants who were experiencing higher depression levels evaluated themselves lower in relation to cognition and the impact of cognitive deficits on their lives, at all three timepoints.

A Pearson's correlation showed a large significant negative correlation between participants' Cognitive Group Self Evaluation scores and distress levels (anxiety and

depression combined) at timepoint 1 (r=-.683; p<.01, 2-tailed) and timepoint 3 (r=-.720; p<.01, 2-tailed) and a Spearman's rho correlation showed a large significant negative correlation between participants' scores on these measures at timepoint 2 (r=-.589; p<.01, 2-tailed). This indicates that participants who were experiencing higher levels of distress evaluted themselves lower in relation to cognition and the impact of cognitive deficits on their lives, at all three timepoints.

8.1.5 Significant Associations (Cognitive Group Self-Evaluation Questionnaire)

See Section 8.1.4 above for details of significant associations found between distress and Cognitive Self-Evaluation measures.

Table 8.1 *Correlation – Main Dependent Variables and Demographic Variables (Age and Time Since Injury) T1-T3*

Variables	CVLT TotFR	CVLT Ints	CVLTR eps	CVLT Learn	CVLT SemC	TMT Cnd1	TMT Cnd2	TMT Cnd3	TMT Cnd4	TMT Cnd5	TMT C4Err	SART TAcc	SART ErrOm	SART ErrC	SART TR	SART TR C
Age T1	-.243	.061	-.297	.045	-.230	-.69	.176	.108	.179	.099	-.154	-.289	.379	-.027	.260	-.313
	p=.18	*p*=.75	*p*=.11	*p*=.81	*p*=.21	*p*=.71	*p*=.34	*p*=.56	*p*=.33	*p*=.60	*p*=.40	*p*=.12	*p*=.04	*p*=.89	*p*=.16	*p*=.09
Age T2	-.366	.25	-.274	.071	**-.519***	-.143	.147	.107	-.071	.124	-.168	-.185	.299	-.215	.404	-.371
	p=.06	*p*=.18	*p*=.14	*p*=.70	***p*=.00**	*p*=.44	*p*=.42	*p*=.56	*p*=.70	*p*=.50	*p*=.36	*p*=.32	*p*=.10	*p*=.25	*p*=.02	*p*=.04
Age T3	-.329	.156	-.078	-.257	-.209	-.043	.061	.167	.024	.033	-.010	-.046	.230	-.178	.363	-.119
	p=.07	*p*=.40	*p*=.68	*p*=.16	*p*=.26	*p*=.82	*p*=.74	*p*=.36	*p*=.90	*p*=.86	*p*=.96	*p*=.81	*p*=.21	*p*=.34	*p*=.05	*p*=.52
TSI T1	-.261	.193	.065	-.108	-.057	-.383	-.369	-.368	-.393	-.393	-.085	-.265	.269	.033	.334	-.334
	p=.16	*p*=.30	*p*=.73	*p*=.56	*p*=.76	*p*=.03	*p*=.04	*p*=.04	*p*=.03	*p*=.03	*p*=.65	*p*=.15	*p*=.14	*p*=.86	*p*=.07	*p*=.07
TSI T2	-.330	.102	.085	-.318	.166	-.208	-.375	-.365	-.397	-.410	-.248	-.166	.178	.030	.278	-.105
	p=.07	*p*=.58	*p*=.65	*p*=.08	*p*=.36	*p*=.26	*p*=.04	*p*=.04	*p*=.02	*p*=.02	*p*=.17	*p*=.37	*p*=.34	*p*=.87	*p*=.13	*p*=.58
TSI T3	-.391	.192	.027	-.116	-.430	-.410	-.233	**-.540***	**-.640***	-.407	-.397	-.258	.280	-.034	.410	-.259
	p=.03	*p*=.30	*p*=.89	*p*=.54	*p*=.02	*p*=.02	*p*=.20	***p*=.00**	***p*=.00**	*p*=.02	*p*=.02	*p*=.16	*p*=.13	*p*=.86	*p*=.02	*p*=.16

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations TSI = Time Since Injury

Table 8.2 *Correlation – Main Dependent Variables and Demographic Variables (Age and Time Since Injury) T1-T3*

Variables	DSF	DSB	DSS	LDSF	LDSB	LDSS	TDSS	Anx	Dep	Tot Dist	SWL	CIQ	CGSE	KBI
Age T1	.165 *p*=.37	-.016 *p*=.93	-.057 *p*=.76	.109 *p*=.55	.002 *p*=.99	-.070 *p*=.71	.074 *p*=.69	.382 *p*=.03	.240 *p*=.19	.342 *p*=.06	.231 *p*=.22	-.020 *p*=.91	-.293 *p*=.12	.026 *p*=.89
Age T2	.170 *p*=.35	.043 *p*=.82	.1 *p*=.59	.194 *p*=.29	.068 *p*=.71	.102 *p*=.58	.220 *p*=.23	.339 *p*=.06	.082 *p*=.66	.213 *p*=.24	-.012 *p*=.95	-.103 *p*=.58	-.280 *p*=.13	.012 *p*=.95
Age T3	.032 *p*=.86	.047 *p*=.80	.084 *p*=.65	.041 *p*=.82	.055 *p*=.77	.020 *p*=.91	.137 *p*=.45	.426 *p*=.02	.229 *p*=.21	.334 *p*=.06	-.134 *p*=.47	-.378 *p*=.03	-.261 *p*=.15	.133 *p*=.47
TSI T1	-.176 *p*=.34	-.3 *p*=.10	**-.539*** ***p*=.00**	-.171 *p*=.35	-.149 *p*=.42	-.488 *p*=.01	-.455 *p*=.01	-.216 *p*=.24	-.308 *p*=.09	-.291 *p*=.11	-.012 *p*=.95	.077 *p*=.68	.093 *p*=.63	.279 *p*=.14
TSI T2	-.239 *p*=.19	-.266 *p*=.14	-.296 *p*=.10	-.225 *p*=.22	-.217 *p*=.23	-.329 *p*=.07	-.299 *p*=.10	-.157 *p*=.39	-.197 *p*=.28	-.189 *p*=.30	.046 *p*=.80	-.161 *p*=.38	-.033 *p*=.86	.082 *p*=.66
TSI T3	-.286 *p*=.11	-.364 *p*=.04	-.183 *p*=.32	-.336 *p*=.06	-.379 *p*=.03	-.111 *p*=.55	-.328 *p*=.07	-.133 *p*=.47	-.091 *p*=.62	-.113 *p*=.54	-.096 *p*=.60	.00 *p*=1	.408 *p*=.02	.082 *p*=.66

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations TSI = Time Since Injury

Table 8.3 *Correlation – Main Dependent Variables and Years of Education (T1-T3)*

Variables	CVLT TotFR	CVLT Ints	CVLT Reps	CVLT Learn	CVLT SemC	TMT Cnd1	TMT Cnd2	TMT Cnd3	TMT Cnd4	TMT Cnd5	TMT C4Err	SART TAcc	SART ErrOm	SART ErrC	SART TR	SART TR C
Yrs of Education T1	.317 *p*=.09	-.270 *p*=.15	-.100 *p*=.60	-.009 *p*=.96	.098 *p*=.61	.280 *p*=.13	.049 *p*=.80	.267 *p*=.15	.265 *p*=.15	.159 *p*=.40	.067 *p*=.72	.309 *p*=.10	-.277 *p*=.14	-.129 *p*=.50	-.137 *p*=.47	.125 *p*=.51
Yrs of Education T2	.172 *p*=.36	-.361 *p*=.05	-.002 *p*=.99	.134 *p*=.47	-.167 *p*=.37	.280 *p*=.13	.116 *p*=.54	.232 *p*=.21	.217 *p*=.24	.182 *p*=.33	.166 *p*=.37	.336 *p*=.07	-.296 *p*=.11	-.327 *p*=.08	.022 *p*=.91	.057 *p*=.76
Yrs of Education T3	.172 *p*=.35	-.337 *p*=.07	.018 *p*=.92	.111 *p*=.56	.043 *p*=.82	.266 *p*=.15	.110 *p*=.56	.266 *p*=.15	.140 *p*=.45	.249 *p*=.18	-.059 *p*=.75	.302 *p*=.11	-.355 *p*=.05	-.373 *p*=.04	-.076 *p*=.69	.031 *p*=.87

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations

Table 8.4 *Correlation – Main Dependent Variables and Years of Education (T1-T3)*

Variables	DSF	DSB	DSS	LDSF	LDSB	LDSS	TDSS	Anx	Dep	Tot Dist	SWL	CIQ	CGSE	KBI
Yrs of Education T1	.259 *p*=.16	.261 *p*=.16	.112 *p*=.55	.327 *p*=.07	.290 *p*=.11	.117 *p*=.53	.213 *p*=.25	.042 *p*=.82	.161 *p*=.39	.113 *p*=.55	-.272 *p*=.15	.074 *p*=.69	-.013 *p*=.95	-.053 *p*=.78
Yrs of Education T2	.368 *p*=.04	.349 *p*=.05	.011 *p*=.95	.379 *p*=.04	.378 *p*=.04	.030 *p*=.87	.211 *p*=.26	-.111 *p*=.55	-.198 *p*=.29	-.146 *p*=.43	.196 *p*=.29	.092 *p*=.62	-.024 *p*=.90	.039 *p*=.84
Yrs of Education T3	.331 *p*=.07	.066 *p*=.72	.162 *p*=.38	.339 *p*=.06	.017 *p*=.93	.182 *p*=.33	.218 *p*=.24	-.132 *p*=.48	-.080 *p*=.67	-.156 *p*=.40	.005 *p*=.98	.313 *p*=.09	.158 *p*=.40	-.121 *p*=.52

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations

Table 8.5 *Correlation – Main Dependent Variables (Neuropsychological Tests) and Anxiety (T1-T3)*

Variables	CVLT TotFR	CVLT Ints	CVLT Reps	CVLT Learn	CVLT SemC	TMT Cnd1	TMT Cnd2	TMT Cnd3	TMT Cnd4	TMT Cnd5	TMT C4Err	SART TAcc	SART ErrOm	SART ErrC	SART TR	SART TR C
Anxiety T1	.236	.214	-.125	.300	-.039	.115	.117	.147	.073	.274	.027	-.262	.249	.185	.098	-.028
	p=.20	*p*=.25	*p*=.50	*p*=.10	*p*=.83	*p*=.53	*p*=.53	*p*=.42	*p*=.69	*p*=.14	*p*=.88	*p*=.16	*p*=.18	*p*=.32	*p*=.60	*p*=.88
Anxiety T2	.172	-.361	-.002	.134	-.167	.280	.116	.232	.217	.182	.166	-.055	.113	-.120	.200	-.219
	p=.36	*p*=.05	*p*=.99	*p*=.47	*p*=.37	*p*=.13	*p*=.54	*p*=.21	*p*=.24	*p*=.33	*p*=.37	*p*=.77	*p*=.11	*p*=.52	*p*=.28	*p*=.24
Anxiety T3	.172	-.337	.018	.111	.043	.266	.110	.266	.140	.249	-.059	.022	.161	-.062	.181	-.088
	p=.35	*p*=.07	*p*=.92	*p*=.56	*p*=.82	*p*=.15	*p*=.56	*p*=.15	*p*=.45	*p*=.18	*p*=.75	*p*=.90	*p*=.39	*p*=.74	*p*=.33	*p*=.64

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations

Table 8.6 *Correlation – Main Dependent Variables (Neuropsychological Tests) and Anxiety (T1-T3)*

Variables	DSF	DSB	DSS	LDSF	LDSB	LDSS	TDSS	CGSE
Anxiety T1	.019	-.019	.137	-.010	.026	.131	.162	**-.607***
	p=.92	*p*=.92	*p*=.96	*p*=.07	*p*=.89	*p*=.47	*p*=.38	***p*=.00**
Anxiety T2	-.021	.143	.102	.035	.168	.121	.110	**-.608***
	p=.91	*p*=.44	*p*=.58	*p*=.85	*p*=.36	*p*=.51	*p*=.55	***p*=.00**
Anxiety T3	-.064	.018	.042	.043	.035	-.035	.127	**-.514***
	p=.73	*p*=.92	*p*=.82	*p*=.82	*p*=.85	*p*=.85	*p*=.49	***p*=.00**

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations (Pearson's correlation in shaded cell)

Table 8.7 *Correlation – Main Dependent Variables (Neuropsychological Tests) and Depression (T1-T3)*

Variables	CVLT TotFR	CVLT Ints	CVLT Reps	CVLT Learn	CVLT SemC	TMT Cnd1	TMT Cnd2	TMT Cnd3	TMT Cnd4	TMT Cnd5	TMT C4Err	SART TAcc	SART ErrOm	SART ErrC	SART TR	SART TR C
Depression T1	.367 *p*=.04	-.180 *p*=.33	-.051 *p*=.79	.332 *p*=.07	.089 *p*=.64	.077 *p*=.68	.082 *p*=.66	.198 *p*=.28	.096 *p*=.60	.308 *p*=.09	.097 *p*=.60	-.002 *p*=.99	.073 *p*=.70	-.126 *p*=.50	.174 *p*=.35	-.040 *p*=.83
Depression T2	.075 *p*=.68	.003 *p*=.99	-.083 *p*=.66	.032 *p*=.86	-.182 *p*=.32	-.001 *p*=1	-.172 *p*=.35	-.274 *p*=.13	-.144 *p*=.43	.107 *p*=.56	.051 *p*=.78	.129 *p*=.49	-.062 *p*=.74	-.131 *p*=.48	.282 *p*=.12	-.038 *p*=.84
Depression T3	.149 *p*=.42	.067 *p*=.72	-.075 *p*=.69	.115 *p*=.54	.204 *p*=.27	-.233 *p*=.20	-.172 *p*=.35	-.213 *p*=.24	-.134 *p*=.47	-.076 *p*=.68	.021 *p*=.91	-.131 *p*=.48	.204 *p*=.27	-.026 *p*=.89	.301 *p*=.10	-.062 *p*=.74

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations

Table 8.8 *Correlation – Main Dependent Variables (Neuropsychological Tests) and Depression (T1-T3)*

Variables	DSF	DSB	DSS	LDSF	LDSB	LDSS	TDSS	CGSE
Depression T1	-.086 *p*=.64	-.004 *p*=.98	.184 *p*=.31	-.050 *p*=.79	.023 *p*=.90	.197 *p*=.28	.132 *p*=.47	**-.611*** ***p*=.00**
Depression T2	-.242 *p*=.18	-.002 *p*=.99	-.050 *p*=.79	-.205 *p*=.26	-.034 *p*=.85	-.021 *p*=.91	-.099 *p*=.59	**-.544*** ***p*=.00**
Depression T3	-.138 *p*=.45	-.121 *p*=.51	-.029 *p*=.87	.052 *p*=.77	-.157 *p*=.39	-.044 *p*=.81	-.012 *p*=.95	**-.525*** ***p*=.00**

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations

Table 8.9 *Correlation – Main Dependent Variables (Neuropsychological Tests) and Distress (T1-T3)*

Variables	CVLT TotFR	CVLT Ints	CVLT Reps	CVLT Learn	CVLT SemC	TMT Cnd1	TMT Cnd2	TMT Cnd3	TMT Cnd4	TMT Cnd5	TMT C4Err	SART TAcc	SART ErrOm	SART ErrC	SART TR	SART TR C
Distress T1	.390	-.039	-.048	.386	.078	.116	.107	.199	.102	.332	.102	-.104	.149	-.026	.170	-.018
	p=.03	*p*=.84	*p*=.80	*p*=.03	*p*=.68	*p*=.53	*p*=.56	*p*=.28	*p*=.58	*p*=.07	*p*=.58	*p*=.58	*p*=.42	*p*=.89	*p*=.36	*p*=.92
Distress T2	.095	.143	-.123	.044	-.252	.041	-.070	-.160	-.127	.217	.028	.065	.001	-.169	.233	-.143
	p=.60	*p*=.44	*p*=.51	*p*=.81	*p*=.16	*p*=.83	*p*=.71	*p*=.38	*p*=.49	*p*=.23	*p*=.88	*p*=.73	*p*=.99	*p*=.37	*p*=.21	*p*=.44
Distress T3	.108	.090	-.181	.045	.120	-.188	-.186	-.176	-.128	-.058	.008	-.111	.215	-.005	.270	-.073
	p=.56	*p*=.63	*p*=.33	*p*=.81	*p*=.52	*p*=.30	*p*=.31	*p*=.34	*p*=.49	*p*=.75	*p*=.96	*p*=.55	*p*=.25	*p*=.98	*p*=.14	*p*=.70

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations

Table 8.10 *Correlation – Main Dependent Variables (Neuropsychological Tests) and Distress (T1-T3)*

Variables	DSF	DSB	DSS	LDSF	LDSB	LDSS	TDSS	CGSE
Distress T1	-.052	.010	.177	-.034	.044	.173	.168	**-.682***
	p=.78	*p*=.96	*p*=.33	*p*=.86	*p*=.81	*p*=.34	*p*=.36	***p*=.00**
Distress T2	-.130	.104	.046	-.079	.123	-.067	.025	**-.589***
	p=.48	*p*=.57	*p*=.80	*p*=.67	*p*=.50	*p*=.72	*p*=.89	***p*=.00**
Distress T3	-.170	-.078	-.005	-.005	-.111	-.051	.019	**-.589***
	p=.35	*p*=.67	*p*=.98	*p*=.98	*p*=.55	*p*=.78	*p*=.92	***p*=.00**

* $p<0.01$ (2-tailed) Non-parametric Spearman's correlations (Pearson's correlation in shaded cells)

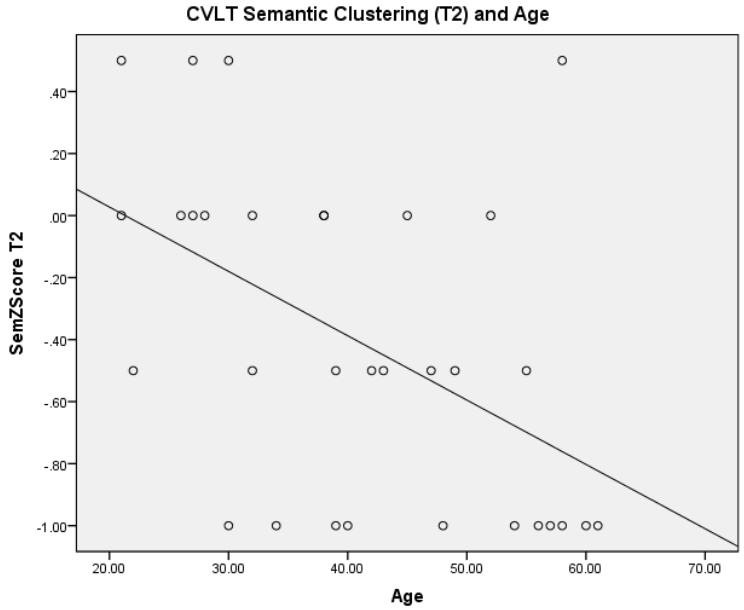
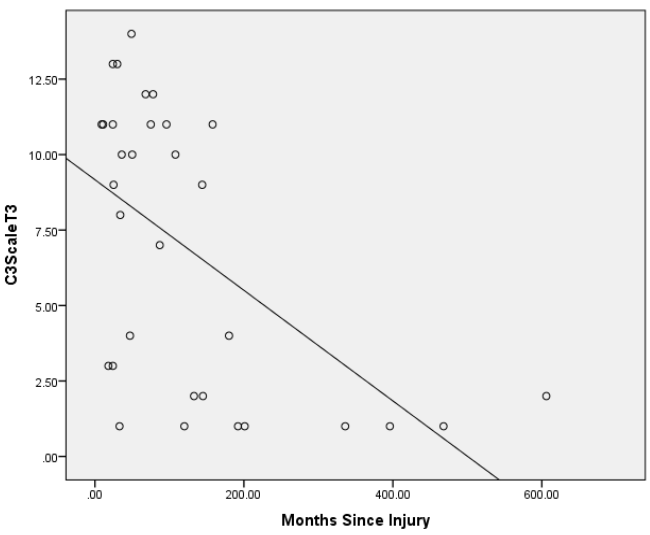


Fig. 8.1 *Age and CVLT Semantic Clustering T2 (N=30)*

(a)



(b)

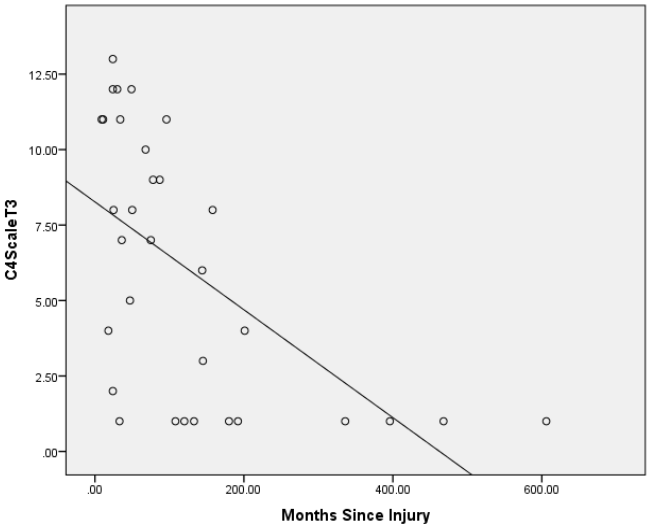


Fig 8.2 *Time Since Injury and TMT Scaled Scores: (a) Condition 3 (T3; N=32) ; and (b) Condition 4 (T3; N=32)*

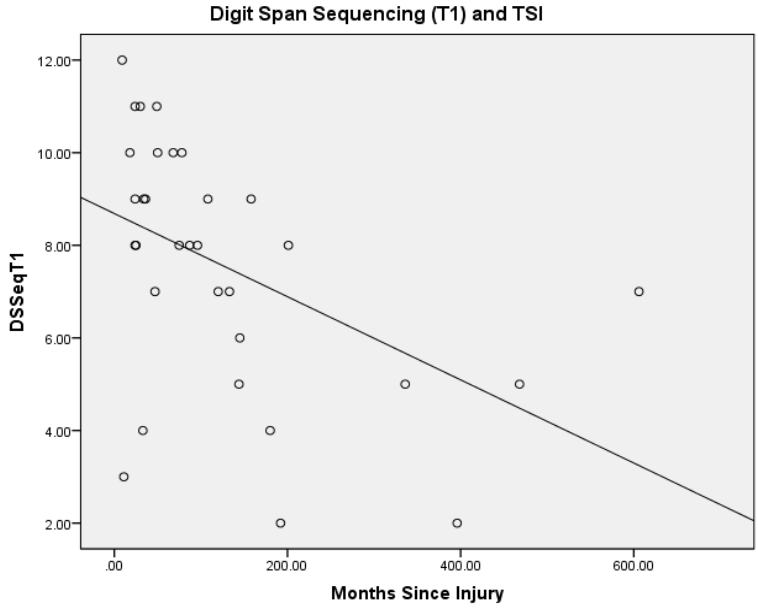
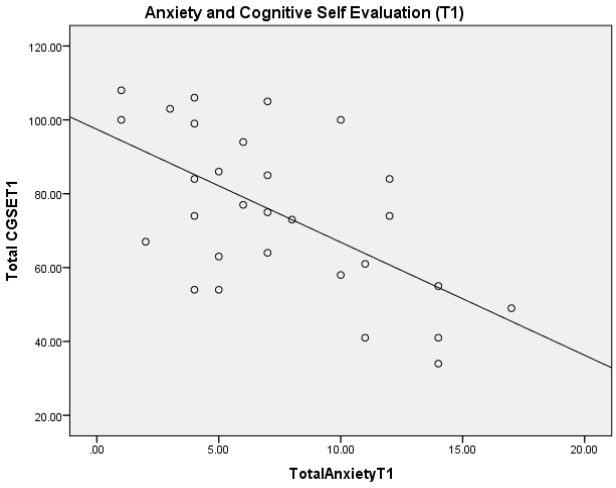
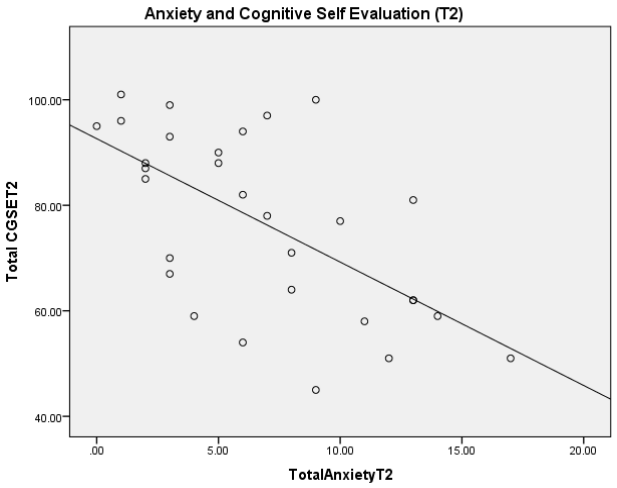


Fig. 8.3 *Time Since Injury and Digit Span Sequencing T1 (N=32)*

(a)



(b)



(c)

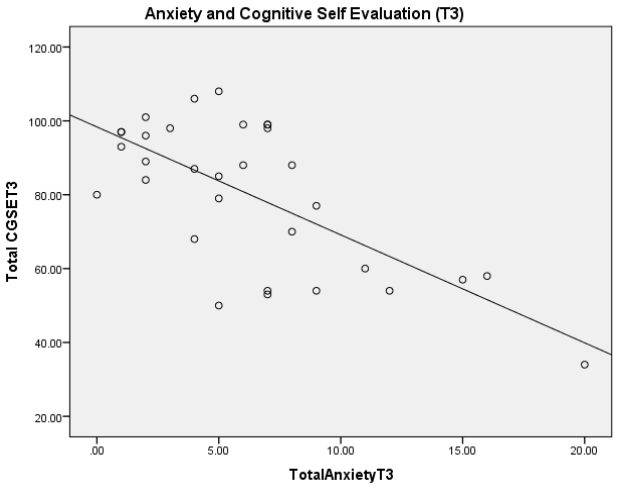
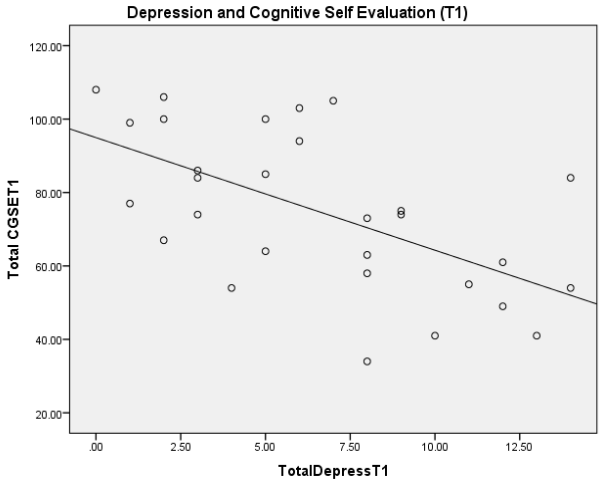
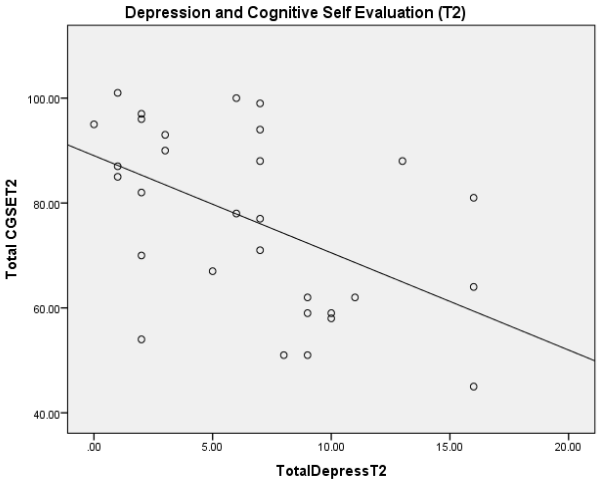


Fig 8.4 *Anxiety and Cognitive Self Evaluation Scores (N=29): (a) T1; (b) T2; and (c) T3*

(a)



(b)



(c)

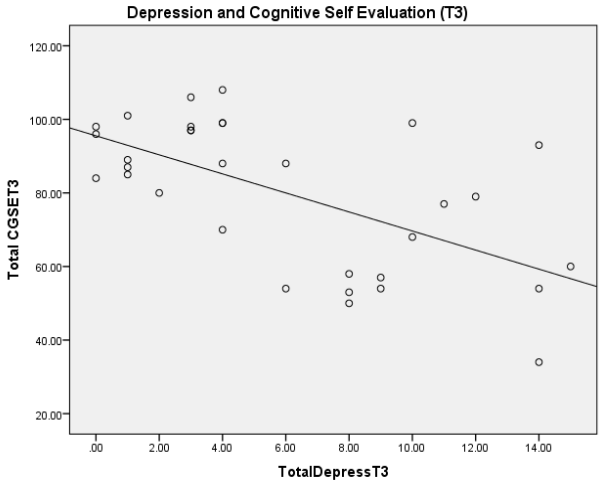
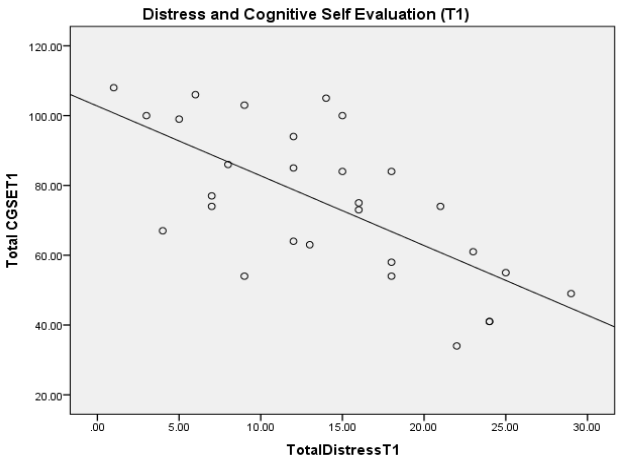
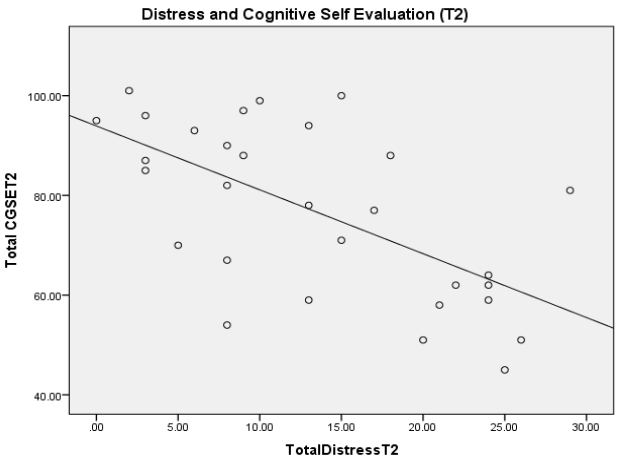


Fig 8.5 *Depression and Cognitive Self Evaluation Scores (N=29): (a) T1; (b) T2; and (c) T3*

(a)



(b)



(c)

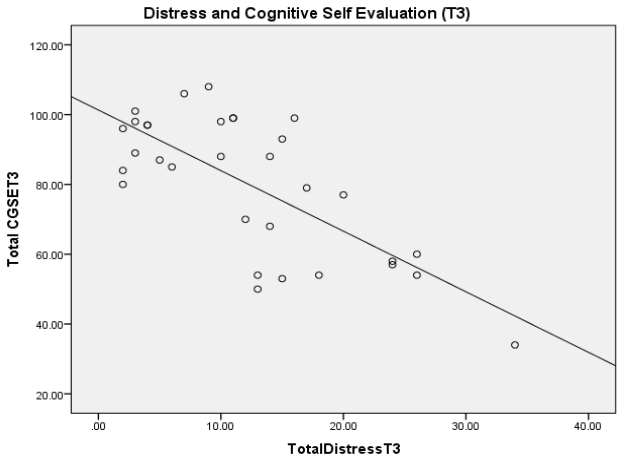


Fig 8.6 *Distress and Cognitive Self Evaluation Scores (N=29): (a) T1; (b) T2; and (c) T3*

Chapter 9

Discussion

9.1 Introduction

This study investigated, in a sample of people with Acquired Brain Injury (ABI), whether participating in a twelve-week cognitive group intervention brings about significant change in areas of cognition, distress, satisfaction with life, community integration, cognitive self-evaluation and knowledge of brain injury. Thirty-two participants (*n*=32) with an ABI took part in this matched control study, with 19 participants in the intervention group (*n*=19) and thirteen in the control group (*n*=13). Participants completed a series of neuropsychological tests and questionnaires at three timepoints, where T1 was pre-intervention, T2 post-intervention and T3 six months later. It was hypothesised that taking part in the programme would result in significant change for participants in relation to cognitive and psychosocial variables, in particular community integration, when compared to a control group.

Results showed a significant overall effect across the three timepoints in the intervention group on the Total Free Recall element of the California Verbal Learning Test (CVLT-II) and an ANOVA test revealed a significant difference for the main effect of time on this sub-scale, with a large effect size. On the Trail Making Test, there was a significant overall effect across the three timepoints for the intervention group on Condition 3 scaled score (letter sequencing task) and for the control group on Condition 4 scaled score (number-letter switching task). There was also a significant difference between T1 and T2 for the control group on Condition 4 scaled score. There was a significant interaction effect (moderate effect size) on Condition 1 scaled score (visual scanning) and Condition 3 scaled score (letter sequencing) and there was a significant difference in Condition 3 scaled scores for the main effect of time (moderate effect size).

On the Sustained Attention Response Task (SART), results showed a significant overall effect across the three timepoints in the intervention group on Total Accuracy scores. However, when an outlier was removed from the intervention group, there was no significant

overall effect across the three timepoints on this element of the test. A significant difference was seen between T1 and T2 for the intervention group on Error of Commission scores and for the control group on Target Reaction Time scores, as part of the SART test. On the Digit Span test, an immediate intervention effect was seen between T1 and T2 for the intervention group on Digit Span Sequencing and Long Digit Span Sequencing and a significant difference between these two timepoints was seen for the control goup on Long Digit Span Sequencing scores. An interaction effect was seen between the two groups on Long Digit Span Sequencing scores (moderate effect). On the Knowledge of Brain Injury meaure, there was a significant difference seen in scores for the main effect of time (moderate effect).

In terms of longitudinal effects, a significant difference was observed in the control group between T1 and T3 on Total Free Recall scores as part of the CVLT-II test and a significant difference observed in this group between T2 and T3 on Learning Slope z scores as part of this test. On the Trail Making Test, a significant difference was seen for the intervention group between T1 and T3 and between T2 and T3 on Condition 1 scaled score (visual cancellation task) and Condition 3 scaled score (letter sequencing task) on this test. On the SART test, a significant difference was seen for the intervention group between T1 and T3 on Total Accuracy scores of this test. On the Cognitive Self Evaluation measure, a significant difference was seen for the control group between T1 and T3.

9.2 Overall Effects Across Three Timepoints

Chapter 7 investigated within group comparisons across the three timepoints, between group comparisons on the various outcome measures and main effects of time and group as well as interaction effects between the two groups.

On the CVLT-II Test, results showed a significant overall effect across the three timepoints in the intervention group on the Total Free Recall element of this test with

participants showing improved performance between T1 and T2, followed by a slight drop in performance at T3. There was also a significant difference for the main effect of time on this sub-scale, with a large effect size.

On the Trail Making Test, there was a significant overall effect across the three timepoints for the intervention group on Condition 3 scaled score (letter sequencing task), with participants showing improved performance between each of the three timepoints. There was also a significant overall effect across the three timepoints for the control group on Condition 4 scaled score (number-letter switching task), with participants improving between T1 and T2, followed by a disimprovement between T2 and T3. There was a significant interaction effect (moderate effect size) on Condition 1 scaled score (visual scanning), with the intervention group's performance disimproving slighlty btween T1 and T2 and then improving between T2 and T3, whilst the control group showed the opposite pattern. There was a significant interaction effect (moderate effect size) on Condition 3 scaled score (letter sequencing) and there was a significant difference in Condition 3 scaled scores for the main effect of time (moderate effect size). The intervention group's performance improved at each timepoint on Condition 3 whilst the control group's performance stayed the same across the timepoints.

On the SART test, results showed a significant overall effect across the three timepoints in the intervention group on Total Accuracy scores, with participants' performance improving at each timepoint. However, when an outlier was removed from the intervention group, there was no significant overall effect across the three timepoints on this element of the test. On the Digit Span test, an interaction effect was seen between the two groups on Long Digit Span Sequencing scores (moderate effect), with the intervention group improving between T1 and T2, followed by a slight disimprovement in performance at T3 whilst the control group showed the opposite pattern.

On the Knowledge of Brain Injury meaure, there was a significant difference seen in scores for the main effect of time (moderate effect). Scores for the intervention group increased on this measure at each timepoint whereas scores for the control group increased between T1 and T2 and then decreased slightly at T3.

9.3 Short-Term Effects: T1 vs T2

On the Trail Making test, there was a significant difference between T1 and T2 for the control group on Condition 4 scaled score (number-letter switching) with participants' performance improving between these two timepoints. On the SART test a significant difference was seen between T1 and T2 for the intervention group on Error of Commission scores with participants making less errors at T2 than T1. For the control group, a significant difference was seen between T1 and T2 on Target Reaction Time scores, with participants demonstrating a faster response to target stimuli at T2 than T1.

On the Digit Span Test, a significant difference was observed between T1 and T2 for the intervention group on Digit Span Sequencing and Long Digit Span Sequencing scores, with the intervention group showing a significant improvement in performance between these two timepoints. A significant difference between T1 and T2 was observed for the control group on Long Digit Span Sequencing scores, with the control group showing a significant disimprovement in performance between these two timepoints.

9.4 Longitudinal Effects: T2 vs T3

A significant difference was observed in the control group between T2 and T3 on Learning Slope z scores as part of the CVLT-II test, with participants performing significantly better on this measure at T3 than T2. On the Trail Making Test, a significant difference was revealed between T2 and T3 for the intervention group on Condition 1 scaled score (visual

cancellation task) and Condition 3 scaled score (letter sequencing task) scores, with participants performing significantly better on these sub-scales at T3 than T2.

9.5 Longitudinal Effects: T1 vs T3

On the CVLT-II test, a significant difference was observed between T1 and T3 for the control group on Total Free Recall scores, with participants performing significantly better at T3 than T1. On the Trail Making Test, a significant difference was observed between T1 and T3 for the intervention group on Condition 1 scaled score (visual cancellation task) and Condition 3 scaled score (letter sequencing task), with participants performing significantly better on this measure at T3 than T1. A significant difference was observed between T1 and T3 for the intervention group on Total Accuracy scores of the SART test, with the group showing a significant improvement in performance between T1 and T3.

On the Cognitive Self Evaluation measure, a significant difference between T1 and T3 scores was observed for the control group, with participants rating their cognitive functioning and the impact of cognitive defictis on their lives, more favourably at T3 than T1.

9.6 Correlation Analysis

Chapter 8 investigated correlations between the main dependent variables and the continuous demographic variables of age, time since injury and years of education. Correlation analysis was also conducted between the HADS variables (anxiety, depression and total distress) and the neuropsychological measures (including cognitive self evaluation). In order to control for type 1 errors, a significance level of $p < .01$ was used.

In relation to the Trail Making Test, less time since injury was associated with higher higher Condition 3 and 4 scaled scores (T3). On the Digit Span test, less time since injury was associated with higher scores on Digit Span Sequencing at T1. In relation to age, lower

age was associated with higher Semantic Clustering scores on the CVLT-II test at T2. On the distress measures, higher anxiety, depression and overall distress (anxiety and depression combined) were associated with lower Cognitive Self-Evaluation scores at all three timepoints. There was no significant correlations between years of education and the main dependent variables.

9.7 Brain Injury Rehabilitation Programmes

As discussed in Chapter 1, reviews conducted by Cicerone and colleagues (Cicerone et al., 2000; Cicerone et al., 2005; Cicerone et al., 2011; Cicerone et al., 2019; Gordon et al., 2006; Rohling et al., 2009) support the effectiveness of cognitive rehabilitation interventions, as well as broader holistic neuropsychological rehabilitation interventions for individuals following TBI and stroke. Professional bodies such as the the European Federation of Neurological Societies recommend the provision of cognitive rehabilitation for people with acquired brain injuries and the Brain Injury Interdisciplinary Special Interest Group (BI-ISIG) of the American Congress of Rehabilitation Medicine (ACRM) argue that comprehensive, holistic rehabilitation programs should be considered practice standard following moderate and severe TBI.

Cognitive rehabilitation interventions are commonly classified as either restorative (or 'bottom-up') or compensatory ('top-down'; Dams-O'Connor & Gordon, 2013). Systematic reviews have concluded that the use of strategies that compensate for memory deficits are the most effective approach to managing memory problems and increasing everyday functioning following brain injury (Cappa et al., 2005; Cicerone et al., 2005; Cicerone et al., 2011). There is substantial evidence to support strategy training for post-acute attention deficits post-TBI (Cicereone et al., 2005) and metacognitive approaches appear to have the best level of

evidence in relation to improving executive functioning (Cicerone et al., 2011; Kennedy et al., 2008; Rohling et al., 2009).

The ABI Ireland Cognitive Group Programme, which is the subject of this thesis, uses a compensatory approach, where participants are taught various compensatory strategies (internal and external), which they can apply in their everyday lives. The programme also includes an emphasis on the development of metacognitive skills (self-awareness of post-injury impairments).

A holistic approach to neuropsychological rehabilitation is taken by ABI Ireland with its Cognitive Group Programme, which focuses on psychoeducation, basic strategy training for cognitive deficits and stress management techniques. There is increasing recognition of the importance of such a holistic approach to rehabilitation for individuals with brain injury (Cicerone et al., 2005; Prigatano, 2013; Wilson, 2017). Symptoms of anxiety and depression are commonly reported following brain injury (McBrinn et al., 2008) and at baseline, both intervention and control groups scored higher than normative data for anxiety and depression. Given that cognition, emotion and psychosocial functioning are interlinked, it is important to deal with emotional issues as part of any cognitive rehabilitation programme (Wilson, 2017).

As discussed in Chapter 1, evidence-based reviews suggest that the most efficacious approach to cognitive rehabilitation is comprehensive day-treatment programmes that include individual and group sessions for several hours per day, several days per week (Cicerone et al., 2000, 2005, 2011). However, this may not be economically viable for community-based neurorehabilitation service providers operating with limited resources. Group-based interventions, such as the Cognitive Group Programme provided by ABI Ireland, can offer a more cost-effective solution. In addition to economic benefits, there are other benefits to a group programme, in particular by providing an opportunity for participants to learn from their peers and gain social support from others in a similar situation to themselves.

Neuropsychological rehabilitation aims to enable people with brain injuries to achieve their optimum level of wellbeing, to reduce the impact of their problems on everyday life and to help them return to their most appropriate environments, which will vary between individuals (Wilson et al., 2017). Community integration is considered one of the ultimate goals of rehabilitation after brain injury (Fortune & Richards, 2017). One of the challenges for neuropsychological rehabilitation programmes, such as the one operated by ABI Ireland, is to ensure that participants apply the learning from the programme to their everyday lives.

9.8 Interpretation of Results

Significant effects were seen for both the intervention and control groups on some specific elements of the neuropsychological tests, including the California Verbal Learning Test (CVLT-II), the Trail Making Test (TMT), the Sustained Attention Response Task (SART) and the Digit Span test. A significant moderate effect for time was seen in scores on the Knowledge of Brain Injury questionnaire. No significant effects were seen for either group on the psychosocial measures of anxiety and depression, satisfaction with life or community integration and a signifcant effect was seen for the control group on the Cognitive Self Evaluation measure.

9.8.1 California Verbal Learning Test (CVLT-II)

The CVLT-II test was used to assess individual's learning and memory skills. An overall effect was seen across the three timepoints in the intervention group on the Total Free Recall subscale of the test, with participants' performance improving between T1 and T2, followed by a slight decrease in performance between T2 and T3. For the control group, a significant difference was observed between T1 and T3 on Total Free Recall scores, with participants performing significantly better at T3 than T1. There was also a significant difference for the

main effect of time on this sub-scale, with a large effect size. A significant difference was observed in the control group between T2 and T3 on Learning Slope z scores (the average number of new words per trial acquired across the five learning trials of List A), with participants performing significantly better on this measure at T3 than T2.

Participants' Total Free Recall scores were below normative data levels at T1 for both groups, which is not surprising given that memory problems are amongst the most commonly reported cognitive deficit arising from ABI (Velikonja et al., 2014). The frontal lobes are involved in working memory tasks that require the temporary storage and manipulation of information (Braver et al., 1997), as required in this test, and these lobes are often damaged by brain injury. Although Total Free Recall performance improved between T1 and T2 for the intervention group, scores remained significantly below (by 33.09 points) normative data levels at T2..

The immediate intervention effect (between T1 and T2) observed may be due to an increased use of compensatory memory strategies, learnt as part of the Cognitive Group Programme. Two sessions of the Cognitive Programme are dedicated to the topic of memory and participants are asked to reflect on their individual memory problems. Homework on week 7 involves participants performing three tasks which require different types of memory strategies to be used and homework on week 8 involves participants completing a daily diary for the period of a week. It is also possible that psychosocial elements of the programme had an impact on participants' memory performance given that cognition, emotion and behaviour are all important factors in the rehabilitation process.

Improved performance on Total Free Recall scores occurred between T1 and T2 for the intervention group but there was a slight drop in performance at T3. Sometimes benefits from an intervention are not sustained long-term and there is a risk of participants forgetting the memory strategies they learnt on a programme or not practising them in real-world

situations. Another possible explanation for these results relates to practice effects, and memory tests in particular are influenced by practice effects (Benedict & Zgaljardic, 1998; Wilson et al., 2000). As discussed in chapter 1, there is also the possibility of a general test-taking benefit in which enhanced performance may occur after repeated examinations, even with different test items (Benedict & Zgaljardic, 1998; Wilson et al., 2000). Given that the greatest practice effects are likely to occur between the first and second examinations on many tests (Benedict & Zgaljardic, 1998; Ivnik et al., 1999), this may provide an explanation for the improvement in Total Free Recall scores seen in the intervention group between T1 and T2. The control group demonstrated a significant improvement in performance on Total Free Recall scores between T1 and T3, with performance improving at each timepoint. Although the baseline scores for this measure were similar for both groups, the control group scored higher (by 4.74 points) than the intervention group at T3. In addition, the control group's Learning Slope scores (the average number of new words per trial acquired across the five learning trials of List A) on the CVLT-II test demonstrated a significant improvement between T2 and T3. These findings indicate that the influence of practice effects, and the benefits of multiple test-taking, is the most likely explanation for the improvement across the three timepoints seen in both groups.

The potential for spontaneous neurological improvement amongst some study participants must also be considered. Two (11%) of the intervention group had acquired their brain injury within the previous 12 months, one 9 months previously and one 11 months previously whilst the minimum time since injury for participants in the control group was 24 months. This raises the possibility of spontaneous recovery amongst some of the intervention participants, which is more likely to occur within one year post-injury (Cope, 1995).

9.8.2 Trail Making Test (TMT)

The Trail Making Test was used to assess participants' executive functioning skills. Executive functioning deficits are one of the most common and persistent sequelae post brain injury (Krasny-Pacini et al., 2014) and arise from damage to the frontal lobes or to circuits that include frontal structures (Stuss, 2011). At baseline, both groups scored lower than normative data levels for Condition 1-5 of the test, which is to be expected, given how common executive functioning deficits are post brain injury.

On Condition 1 (visual scanning) of the test, a delayed intervention effect (between T2 and T3) and a long-range intervention effect (between T1 and T3) was seen in the intervention group, with performance improving at later timepoints. There was a significant interaction effect (moderate effect size) on Condition 1 scaled score, with the intervention group's performance disimproving slighlty btween T1 and T2 and then improving between T2 and T3, whilst the control group showed the opposite pattern.

On Condition 3 (letter sequencing), an overall effect was seen across the three timepoints in the intervention group, with participants' performance improving at each timepoint. An ANOVA test revealed a significant interaction effect (moderate effect size) on Condition 3 scaled score and there was a significant difference in Condition 3 scaled scores for the main effect of time (moderate effect size). The intervention group's performance improved at each timepoint on Condition 3 whilst the control group's performance stayed the same across the timepoints.

On Condition 4 (number-letter switching task), there was a significant overall effect across the three timepoints for the control group with participants improving between T1 and T2, followed by a disimprovement between T2 and T3. A significant difference was observed between T1 and T2 for the control group on this element of the test. From a clinical perspective, the only mean score to reach normative data levels was on Condition 4 All

Errors (scaled score) for the control group. Scores for this group increased from below normative data levels at T1 (*M*8.77) to reach normative data levels at T2 (*M* 10.31) and scores remained the same at T3 (with an increased scale score indicating better performance). The mean score for the intervention group on this measure increased slightly from T1 (*M* 8.05) to T2 (*M* 8.11) but remained below normative data levels at T2.

According to the authors of the Trail Making Test, the primary executive function task is condition four (Number-Letter Switching), which is meant to assess flexibility of thinking on a visual-motor sequencing task. The other four conditions of the test allow the examiner to gain information regarding an examinee's ability at component skills including visual scanning, number sequencing, letter sequencing, and motor speed. By including these measures, the examiner can determine whether a deficient score on the switching condition is related to a deficit in cognitive flexibility and/ or to an impairment in one or more of the underlying component skills. It is interesting to note that an overall effect was seen across the three timepoints in the control group on Condition 4 and a significant difference observed between T1 and T2 on this measure, with participants' performance improving between T1 and T2 but performance disimproving between T2 and T3. For the intervention group, mean scores across the three timepoints increased slightly but no significant differences were observed. The improvements seen in the control group are most likely due to practice effects and a test-taking benefit due to tests being repeated at each timepoint.

The effects observed on Condition 1 and 3 in the intervention group may be due to an increased use of cognitive strategies learnt by participants as part of the Cognitive Programme. Effects observed on Condition 1 (visual scanning) and Condition 3 (letter sequencing) are more likely to be due to improved attention or visual scanning, rather than improved 'higher order' executive functioning skills. As part of the Cognitive Group programme, participants cover the topic of attention over two sessions of the programme. It is

interesting to note that the significant differences observed on Condition 1 and Condition 3 for the intervention group were seen between T1 and T3 and between T2 and T3 but not between T1 and T2. Given that practice effects are usually observed between T1 and T2, these results indicate that the improvements seen in performance may not be due to practice effects.

As with the CVLT-II test results, the possibility of spontaneous neurological improvement influencing performance on the Trail Making test must also be considered. This is particularly relevant to the intervention group where two participants (11%) had acquired their brain injury within the previous 12 months, in comparison to none of the control group participants falling into this 'early stage' category. It is interesting to note that correlation analysis revealed that less time since injury was associated with better performance on Condition 3 and Condition 4 of the Trail Making test at T3. 21% (*n*=4) of the intervention group and 15.4% (*n*=2) of the control group had acquired their brain injury within the previous 24 months, suggesting that the intervention group may have had an advantage over the control group on this test.

It is also possible that psychosocial elements of the programme had an impact on participants' performance. The mean score for both groups on Total Distress decreased at each timepoint but remained above normative data levels at T3. For the intervention group, there was a decrease across the three timepoints in the number of participants who were in the moderate and severe anxiety categories, from 5 participants at T1 to 2 participants at T3. There was also a decrease in the number of intervention participants who were in the moderate and severe depression categories, from 4 participants at T1 to 3 participants at T3. For the control group, the number of participants in the moderate and severe categories for anxiety and depression remained the same over the three timepoints (*n*=3). Correlation

analysis revealed no significant correlations between anxiety, depression or distress and Trail Making test scores.

9.8.3 Sustained Attention Response Task (SART)

Deficits of attention are a common consequence of head injury that greatly impede the recovery of other cognitive and functional abilities (Park & Ingles, 2001). The prefrontal cortex is among many structures involved in attention and the right prefrontal cortex is considered important for sustained attention (Vendrell, et al., 1995). Even quite a small reduction in an individual's attention ability may significantly reduce the capacity for new learning and affect academic performance (Kinsella et al., 1997; Kinsella, 1998). Attentional deficits can result in distractibility, the neglect of environmental cues, difficulties with multi-tasking and being unable to concentrate for a sustained period of time (Entwistle & Newby, 2013). Two of the sessions on the Cognitive Group Programme are dedicated to the topic of attention and include strategies to manage deficits in attention. Programme participants complete homework exercises designed to raise their awareness of their individual attention deficits.

The SART test is designed to assess an individual's sustained attention capability. The test is a computerised sustained attention task with a duration of 4.3 minutes and examinees must withhold clicking a mouse on one of nine single-digit number targets (number 3). An overall effect was seen across the three timepoints in the intervention group on Total Accuracy scores, with participants' performance improving at each timepoint. However, there was an outlier (reference no. 9) in the intervention group on Error of Omission scores at T1, with this person performing very poorly on this measures at T1 when compared to the other participants in their group. Total Accuracy scores are calculated based on the numbers of errors of omission and errors of commission and therefore the outlier was

removed from analysis to determine the effect it was having on Total Accuracy scores. When the outlier was removed, within group analysis revealed that there was no significant difference on Total Accuracy scores for the intervention group at T1. A long-range intervention effect (between T1 and T3) was also observed in the intervention group on Total Accuracy scores and when the outlier (reference no. 9) was removed from analysis, the signifcant effect remained.

An immediate intervention effect (between T1 and T2) was observed on Error of Commission scores for the intervention group, with performance improving between T1 and T2. Error of Commission relates to a person failing to inhibit their response to a stimulus (the number 3). The significant difference observed in Error of Commission scores may be due to an increased use of learnt strategies for attention by study participants. Although there may be an element of practice effect or general test-taking benefit behind the improvement between T1 and T2, the SART test has been found to be free of practice effects (Di Rosa et al., 2014). It is interesting to note that improvement on Total Accuracy scores was seen between T1 and T3 for the intervention group, suggesting that gains in attentional ability have been sustained beyond the intervention. It is also interesting to note that there was no significant difference observed in Total Accuracy or Error of Commission scores for the control group across the three timepoints, as this group would have benefited from the same practice effects. For the control group, a significant difference was observed between T1 and T2 on Target Reaction Time scores, indicating a faster response to target stimuli between T1 and T2. Although this finding has been noted, reaction time on this test was not a key measure of interest in this study.

As with other tests discussed above, psychosocial elements of the programme may have had an impact on participants' performance on this test of attention. The mean score for both groups on Total Distress decreased at each timepoint and in the intervention group, there

was a decrease across the three timepoints in the number of participants who were in the moderate and severe anxiety categories, and the moderate and severe depression categories. Correlation analysis revealed no significant correlations between anxiety, depression or distress and SART test scores. There is also potential for spontaneous neurological improvement amongst some of the intervention group participants over the nine month period of testing.

The SART has proven to have a good correlation with reported everyday attentional failures and performance (Robertson et al., 1997), however it has never been demonstrated that improvement on this test is correlated with improvement in everyday functioning (Krasny-Pacini et al., 2014). A study by Levine et al. (2011) found no improvement on a questionnaire on everyday cognitive failures despite study participants' performance improving significantly on the SART. Therefore, gains seen in the intervention group on this measure may not generalise to everyday situations. It is interesting to note that there was no significant differences observed across the three timepoints for the intervention group on the Community Integration measure or the Cognitive Group Self Evaluation questionnaire, despite the improvements observed on the SART test for this group.

9.8.4 Digit Span Test

The Digit Span test was used to test working memory and cognitive flexibility. Each sub-test (forward, backward, sequencing) involves different mental activities and is affected differently by brain damage (Lezak et al., 2012). Studies have shown that the right dorsolateral prefrontal cortex is involved in forward and reversed digit repetition. In addition, bilateral inferior parietal lobule, the anterior cingulate, and medial occipital cortex activate for both digit span forward and backward (Gerton et al., 2004), with the involvement of

occipital and parietal areas suggesting the use of a visual imagery strategy (Lezak et al., 2012).

An interaction effect was seen between the two groups on Long Digit Span Sequencing scores (moderate effect), with the intervention group improving between T1 and T2, followed by a slight disimprovement in performance at T3 whilst the control group showed the opposite pattern. An immediate intervention effect was observed for the intervention group on Digit Span Sequencing and Long Digit Span Sequencing scores, with participants' performance improving between T1 and T2.

The Digit Span Sequencing part of the test involves the examiner reading out a sequence of numbers and the examinee must recall the numbers in ascending order. This requires the examinee to use attention and working memory skills, as they mentally manipulate the numbers before repeating them back in ascending order.

A significant difference was also observed between T1 and T2 for the control group on Digit Span Sequencing and Long Digit Span Sequencing scores, however in comparison to the intervention group, participants' performance disimproved between these two timepoints. This suggests that the improvement seen in the intervention group is less likely to be due to pracice effects but rather due to an increased use of compensatory strategies by study participants around attention and memory. In support of this argument, practice effects have been found to be small to negligible for the Digit Span Test (McCaffrey et al., 2000; Wilson, et al., 2000).

From a clinical perspective, the mean score for the intervention group (*M*9.11) on Total Digit Span (scaled) increased from just below normative data levels (10) at T1 and stayed close to the normative data level at T2 (*M*10.05) and T3 (*M*9.74). The mean score for the control group on this measure decreased slightly at eah timepoint and remained below normative data levels at T3 (*M* 7.69).

Psychosocial elements of the programme may have had an impact on participants' performance on this test. As discussed earlier, the mean score for both groups on Total Distress decreased at each timepoint and in the intervention group, there was a decrease across the three timepoints in the number of participants who were in the moderate and severe anxiety categories, and the moderate and severe depression categories. Correlation analysis revealed no significant correlations between anxiety, depression or distress and Digit Span scores. There is also potential for spontaneous neurological improvement amongst some study participants over the nine month period of testing. Two intervention group participants (11%) had acquired their brain injury within the previous 12 months, in comparison to none of the control group participants falling into this 'early stage' category, and therefore there is a higher likelihood of spontaneous neurological improvement being seen in the intervention group.

Correlation analysis revealed that less time since injury was associated with higher scores on Digit Span Sequencing at T1. 21% (*n*=4) of the intervention group had acquired their brain injury within the previous 24 months, compared to 15.4% (*n*=2) of the control group, suggesting a possible advantage to the intervention group on this test.

9.8.5 Anxiety and Depression

No significant difference was found between the three timepoints for either group on the Hospital Anxiety and Depression Scale (HADS). At baseline, the intervention group scored higher than normative data levels for anxiety (by 0.65 points) and depression (by 2.21 points) and the control group also scored higher than normative data levels for anxiety (by 1.71 points) and depression (by 4.09 points). Chi square analysis revealed no significant difference between the two groups in relation to anxiety or depression scores at baseline. The anxiety and depression levels seen at baseline are not surprising, given that symptoms of anxiety and

depression are commonly reported following brain injury (McBrinn et al., 2008). The prevalence of depression is similar after both stroke and TBI with the order of 20–40% affected at any point in time in the first year, and about 50% of people experiencing depression at some stage (Fleminger et al., 2003). McBrinn et al. (2008) found that people with brain injury who had better awareness of their difficulties had higher emotional distress, regardless of time since injury. As survivors of brain injury become more aware of their losses and the implications of the injuries for their life goals and social roles they may suffer more emotional distress (Williams & Evans, 2003).

Participants on the Cognitive Group Programme may have implemented the strategies they learnt for managing stress and anxiety, even after the programme ended, resulting in a decrease in anxiety and depression levels at T3 and mean anxiety scores falling to below normative data levels. One session of the programme is dedicated to the topic of stress and anxiety and attendees receive practical guidance on relaxation techniques. For homework, participants monitor their mood over the following two weeks as well as completing relaxation record sheets. Attendance at the programme may have reminded participants of the long-term consequences of their brain injury and may explain the small increase in depression levels from baseline to T2, reducing again at T3.

Correlation analysis revealed that participants who were experiencing higher anxiety, depression and distress levels, evaluated themselves lower in relation to cognition and the impact of cognitive deficits on their lives, at all three timepoints.

9.8.6 Satisfaction With Life

Individuals with brain injury have been found to report lower levels of life satisfaction in comparison with healthy individuals (Dijkers, 2004). In a study by Stalnacke (2007), a strong correlation was found between depression and life satisfaction, indicating that the level of life

satisfaction decreases with increasing scores of depression. Another study by Wood & Rutterford (2006a) found that injury severity was predictive of life satisfaction. In the current study, the majority of participants had a severe brain injury (74% in the intervention group and 77% in the control group), and so it is not surprising that four intervention group participants (21%) and four control group participants (31%) fell into the categories of 'extremely dissatisfied with life' or 'dissatisfied with life' at baseline. At T2, five intervention group participants (26%) and five control group participants (38%) fell into these categories and at T3 four intervention group participants (21%) and seven control group particiapnts (54%) fell into these categories. Interestingly, the number of participants in the intervention group who fell into the category of 'highly satisfied with life' increased from two at T1 (11%), to three at T2 (16%) and five at T3 (26%), whilst the number of control group participants in this category increased from none at T1, to one at T2 (8%) and two at T3 (15%). Attendance at the Cognitive Group programme may have influenced participants' more positive self-assessment of their satisfacation with life at T2 and T3.

No significant difference was found between the three timepoints for either group on the Satisfaction With Life Scale (SWLS). Satisfaction with life is considered to be a key factor in successful brain injury rehabilitation as it encompasses such a wide range of life features (Mailhan et al., 2005). It is interesting to note that participants' performance improved on some elements of the neuropsychological tests across the three tmepoints, however there was no significant difference observed in Satisfaction With Life scores. An important consideration in studies such as this is that cognitive test score gains often do not generalise to everyday situations (Carney, Chesnut, Maynard, Mann, Patterson & Helfand, 1999; Goranson et al., 2003) and this could provide some explanation for the lack of significant change in Satisfaction With Life scores over the nine month study period. Another factor to consider is that depression levels in both groups remained above normative data

levels at each of the three timepoints and this could have influenced Satisfaction With Life scores. Previous research by Stalnacke (2007) found a strong correlation between depression and life satisfaction, indicating that the level of life satisfaction decreases with increasing scores of depression. In a study by Goverover & Chiaravalloti (2014), they found that symptoms of depression were significantly associated with lower satisfaction with life as well as self-reports of poor memory abilities and lower quality of life.

9.8.7 Community Integration

Community integration is considered to be one of the ultimate goals of rehabilitation after brain injury (Fortune & Richards, 2017) and involves a person's ability to engage in roles in the home, in relationships, and at work or education. The primary outcome measure for this study is community integration and this was assessed using the Community Integration Questionnaire (CIQ; Willer et al., 1993). The CIQ consists of 15 items that measures three aspects of community integration: (1) home integration, which includes the ability to perform activities of daily living such as housework, preparing meals, shopping for groceries etc.; (2) social integration, which includes the ability to manage personal finances, participate in leisure activities, visit friends or relatives etc.; and (3) productivity, which includes the frequency of travel outide the home and participation in employment, training or volunteer activities.

No significant difference was found between the three timepoints for either group on the Community Integration measure. Many studies have shown that individuals with severe traumatic brain injuries may have difficulty resuming occupational involvement (Goranson et al., 2003) and indeed only 21% of the intervention group and 31% of the control group were engaged in gainful activity (that is engagement in full-time or part-time work, education or volunteer work). The fact that 74% of the intervention group had a severe brain injury may

have been a factor in CIQ scores across the three timepoints. As discussed earlier, cognitive test score gains often do not generalise to everyday situations (Carney et al., 1999; Goranson et al., 2003) and so despite the fact that the intervention group's performance improved on some elements of the neuropsychological tests over a nine month period, these gains may not have generalised to have an effect on roles in the home, in relationships, at work or in education for the participants.

The inclusion of homework on the Cognitive Group Programme aims to assist with the transfer of learning from the programme to the person's everyday life, however new strategies learnt may not be sustained over a long period of time if a person does not actively practise these new strategies. Internal strategies in particular, may not be used spontaneously outside clinical settings by individuals with severe memory impairment (Velikonja et al., 2014). Support from family, friends and professionals can assist a person to implement new strategies and develop new habits. The majority of intervention group participants (79%) were living with family, a partner or in supported living and so were likely to have had a support network in place.

A review by Dijkers (1997) found gender-dependent changes on the CIQ with women reported as being more integrated in the home and men reported as being more integrated in productivity. This may have affected the results in this study as the majority of participants were male (79% in the intervention group and 77% in the control group) and so it is less likely to see changes for males in the home integration subscale of the CIQ. Another criticism of the CIQ made by Hall, Bushnik, Lakisic-Kazazic, Wright & Cantagallo (2001) is that it may lack sensitivity in detecting change as the result of an intervention. For this reason, the inclusion of significant other ratings would have been a useful addition to the study. Goranson et al. (2003) describe the CIQ as a rather blunt instrument and recommends the use of more detailed, more extensive and/or more direct measures of productivity and other

aspects of brain injury outcome in a non-self-report format which would likely provide better evaluation of rehabilitation programme effectiveness.

9.8.8 Cognitive Group Self Evaluation

The Cognitive Group Self-Evaluation Questionnaire was administered to participants so that they could rate their level of cognitive difficulty post brain injury and the impact it has on their life on a scale from 0 (no difficulty) to 5 (severe difficulty). Given that participants in the intervention group showed improvements on many elements of the neuropsychological tests, it was anticipated that there would be an increase in their scores on this questionnaire. However it was the control group that showed a significant increase in how they rated their cognitive abilities between T1 and T3. One possible explanation for this is that for participants in the intervention group, awareness of their deficits may have been raised by attending the Cognitive Group Programme and this may have been reflected in their self-reports. Another possible explanation is that participants in the control group may have felt more positive, given that they were coming to the end of the waiting list for attending a Cognitive Group Programme. The time gap between Timepoint 1 and 3 was nine months and it is possible that other factors mediated the improvement in scores for control group participants, such as other treatments and therapies.

It is interesting to note that correlation analysis revealed that participants who were experiencing higher anxiety, depression and distress levels, evaluated themselves lower in relation to cognition and the impact of cognitive deficits on their lives, at all three timepoints. Therefore, distress levels may have been a mediating factor in the lack of significant change in cognitive self evaluation scores in the intervention group. It is also worth noting that accuracy of self-reports in a brain injury population can be an issue given that poor awareness of deficits is prevalent (Flashman & McAllister, 2002; Vanderploeg, Belander, Duchnick &

Curtiss, 2007). There is also the possibility of 'feel good' or expectancy effects with self-report measures (Berg, Koning-Haanstra, & Deelman, 1991; Thickpenny-Davis & Barker-Collo, 2007) which could provide an explanation for the significant difference in scores between T1 and T3 in the control group.

9.8.9 Knowledge of Brain Injury

The Knowledge of Brain Injury Questionnaire was administered to participants in order to assess their level of knowledge of brain injury (for example an understanding of fatigue management or an understanding of strategies for memory problems) over a nine month period. Given that the Cognitive Group Programme educates participants about brain injury, including the structure of the brain and how it gets damaged, recovery after a brain injury, lobes of the brain and their function, and strategies to manage cognitive deficits, it was anticipated that there would be a significant improvement on this measure for the intervention group. There was a significant difference seen in scores for the main effect of time (moderate effect), with mean scores for the intervention group increasing at each timepoint whereas mean scores for the control group increased between T1 and T2 and then decreased slightly at T3. This result indicates that participants on the Cognitive Group Programme appear to have increased their knowledge of brain injury following attendance at the programme and retained this knowledge 6 months later. The increase in mean scores for the control group between T1 and T2 may reflect other sources of education from ABI services participants were accessing and/or a general placebo effect from taking part in the research. These confounding variables also apply to the intervention group and therefore effects seen for the intervention should be interpreted with caution.

9.9 Theoretical, Clinical and Research Implications

It is important to consider the theoretical and clinical implications of the findings from this study and to consider future studies which would further build on the evidence base for neuropsychological rehabilitation.

In Chapter 1, it was hypothesised that participation in the Cognitive Group programme would result in significant change for participants in the cognitive variables of attention, memory and executive functioning, when compared to a control group, and changes would last beyond the programme (hypothesis 1). The California Verbal Learning Test-Second Edition (CVLT-II) was used to assess participants' learning and memory skills and although significant improvements were seen for the intervention group on Total Free Recall scores between T1 and T2, significant improvements were also seen for the control group between T2 and T3. The control group also showed a significant improvement between T2 and T3 for Learning Slope z scores (the average number of new words per trial acquired across the five learning trials of List A), whilst no change was seen for the the intervention group on this measure between T2 and T3.

As discussed earlier, the most likely explanation for the improvements seen in both groups is the influence of practice effects, and the benefits of multiple test-taking. There is also the potential for placebo effects due to additional individualised attention received by participation in a research study. Memory tests are particularly vulnerable to practice effects as individuals can learn the material, except for those who are seriously memory-impaired (Wilson et al., 2000). The CVLT (Delis, et al., 1987) has been shown to be vulnerable to significant practice effects in a psychiatric population (Hawkins & Wexler, 1999) and a HIV-infected population (Duff et al., 2001). Future intervention studies should consider using alternative forms of the CVLT-II at different timepoints as a way of minimising practice effects. Practice effects can still occur with the use of alternative forms where individuals

learn to use an effective test-taking strategy or have acquired "test-wiseness" (Beglinger et al., 2005), but their use minimises the effect of practice (Lezak, 2012). In addition to using alternative forms, two or more baseline assessments could be introduced before the main assessments, an approach suggested by McCaffrey & Westervelt (1995) as a way to minimise practice effects.

The ABI Ireland programme introudces basic compensatory strategy training for memory deficits. Although there is a sound evidence base for the use of compensatory strategies for memory difficulties after TBI or stroke (Cicerone et al., 2011), the use of appropriate instructional techniques is considered important (Velikonja et al., 2014). Such techniques may include errorless learning, spaced retrieval and use of vanishing cues (Clare & Jones, 2008; Ehlhardt, et al., 2008; Grandmaison & Simard, 2003; Haslam, et al., 2011; Piras et al., 2011). The ABI Ireland Programme does not include such instructional techniques and therefore a more comprehensive form of strategy training which includes well-recognised instructional techniques is recommended.

In relation to working memory training, current research and guidelines advocate the use of computer-based training programmes as an adjunct to evidence-based instructional and compensatory strategies (Nadar & McDowd, 2010; Velikonja et al., 2014). The inclusion of computer-based training on the ABI Ireland programme may have resulted in more significant change for the intervention group. Computer-based training should be considered by ABI Ireland as a way of enhancing the current programme and follow-up research carried out to test the effectiveness of such an approach.

It is of interest to see the significant improvements that the intervention group made on the Digit Span Sequencing and Long Digit Span Sequencing elements of the Digit Span test, which was used to test working memory and cognitive flexibility in this study. It is also interesting from a clinical perspective to see that mean scores for the intervention group on

Digit Span scaled scores reached normative data levels at T2 and T3 whilst scores for the control group remained below normative data levels at all timepoints. It is possible that these improvements reflect an improvement in attentional ability, as the Digit Span test can be used as a test of attention (Hebben & Milberg, 2002), although the clinical utility of using Digit Span as a measure of everyday attention has been questioned (Groth-Marnet & Baker, 2003).

The Trail Making test was used to assess participants' executive functioning skills. The primary executive function task is condition four (number-letter switching), which is meant to assess flexibility of thinking on a visual-motor sequencing task (Delis et al., 2001). As discussed earlier, only the control group showed a significant improvement (between T1 and T2) on the primary executive function task (condition four, number-letter switching), and the most likely explanation for the improvements seen in this group is practice effects, a general test-taking benefit and placebo effects.

The interaction effects (moderate effect size) seen on Condiiton 1 (sacled score; visual scanning) and Condition 3 (scaled score; letter sequencing) of the Trail Making test are interesting, with improvement seen in the intervention group on Condition 1 (between T2 and T3) and Condition 3 (across all three timepoints). These effects observed are more likely to be due to improved attention or visual scanning, rather than improved 'higher order' executive functioning skills. However, the various versions of the Trail Making Test that are available have been shown to be vulnerable to practice effects (Buck et al., 2008; Homack et al., 2005; Naglieri & Das, 1997; Reynolds, 2002) and therefore caution should be exercised in interpretation of findings. Executive functioning deficits are considered particularly difficult to capture in formal testing (Wall et al., 2013) and therefore ratings from significant others would enhance future studies by determining generalisability of improvements to everyday situations.

In relation to improving executive functioning, metacognitive approaches appear to have the best level of evidence (Cicerone et al., 2011; Kennedy et al., 2008; Rohling et al., 2009) and INCOG strongly recommend intervention programmes that incorporate metacognitive strategies for planning and problem-solving, focusing on everyday problems and functional outcomes (Tate et al., 2014). Although the ABI Ireland programme uses a metacognitive approach, it does not incorpotate a recognised approach such as Goal Management Training (GMT) which is one of the best known and most extensively studied metacognitive approaches (Krasny-Pacini et al., 2014). Some studies have suggested that interventions using GMT combined with other training methods are more effective than GMT-alone interventions (Krasny-Pacini et al., 2014; Miotto et al., 2009; Novakovic-Agopian et al., 2011; Spikman et al., 2010) and this approach could be considered by ABI Ireland as a way of enhancing the current programme. Follow-up research is recommended to test the effectiveness of this approach.

There is substantial evidence to support strategy training for post-acute attention deficits post-TBI (Cicereone et al., 2005). The ABI Ireland programme includes basic strategy training for attention and an emphasis on the development of metacognitive skills (self-awareness of post-injury impairments). The programme also aims to increase awareness of the importance of environmental restructuring in order to maximise functioning, which is supported by INCOG recommendations. It is therefore encouraging to see the significant improvement in scores for the intervention group on elements of the SART test, including Total Accuracy (between T1 and T3) and Error of Commission (between T1 and T2) and further studies to replicate this finding would be of interest. The significant change observed in the intervention group on Condition 3 of the Trail Making test, across all three timepoints, may also reflect an increase in attentional ability for this group. It has never been demonstrated that improvement on the SART test is correlated with improvement in everyday

functioning (Krasny-Pacini et al., 2014), and therefore it would be of interest to explore generalisation of gains to everyday life in any future studies, through significant other ratings, self-reports and ecologically valid tests.

The SART test has been found to be free of practice effects (Di Rosa et al., 2014), however there may be a general test-taking benefit from the same test being used at three timepoints. However, no significant change was observed for the control group on Total Accuracy or Error of Commission scores and therefore the general test-taking benefit is less likely to be significant for this test. As discussed earlier, psychosocial elements of the programme may have had an impact on participants' performance on this test and there is also potential for spontaneous neurological improvement amongst some of the intervention group participants over the nine month period of testing.

In chapter 1, it was hypothesised that participation in the Cognitive Group programme would result in significant change for participants in the psychosocial variables of distress and satisfaction with life, when compared to a control group and these changes would last beyond the programme (hypothesis 2). Although there was no significant differences revealed for either group on HADS (Hospital Anxiety and Depression Scale) scores, from a clinical perspective, the intervention group's mean anxiety score reduced to 0.4 points below normative data at T3. The mean score for both groups on Total Distress (anxiety and depression combined) decreased at each timepoint but remained above normative data levels at T3. For the intervention group, there was a decrease across the three timepoints in the number of participants who were in the moderate and severe anxiety categories, from 5 participants at T1 to 2 participants at T3. There was also a decrease in the number of intervention participants who were in the moderate and severe depression categories, from 4 participants at T1 to 3 participants at T3. For the control group, the number of participants in

the moderate and severe categories for anxiety and depression remained the same over the three timepoints (*n*=3).

Cognitive Behavioural Therapy (CBT) interventions have the strongest evidence base for improving psychological wellbeing following brain injury (Ownsworth & Gracey, 2017). The ABI Ireland programme does not incorporate CBT, but covers the topics of stress and anxiety and participants receive practical guidance on relaxation techniques. Participants complete mood monitor and relaxation record sheets for homework over a two week period. It is interesting to note the reduction in anxiety levels for the intervention group, to below normative data levels and the reduction in those falling into the moderate and severe categories for anxiety and depression for this group. This may reflect the use of relaxation strategies and mood monitoring, learnt as part of the programme, as well as the positive benefits of attending a group programme and sharing experiences with a peer group. It would be of interest to conduct further research investigating the effect of attendance at the Cognitive Group programme for those who are also receiving a CBT intervention on an individual basis, to determine if both interventions together had a significant effect on participants' distress levels. The provision of CBT as an adjunct to the Cognitive Group Programme could also be considered.

Although there was no significant differences found in Satisfaction With Life scores across the timepoints for either group, from a clinical perspective, the number of intervention group participants who scored in the 'satisfied' or 'highly satisfied' categories increased from *n*=7 at T1 to *n*=8 at T2 and *n*=9 at T3, remaining below normative data levels at T3. Attendance at the Cognitive Group programme may have influenced participants' more positive self-assessment of their satisfacation with life at T2 and T3. As discussed above, if programme participants who were also receiving a CBT intervention were included in a follow-up study, it would be interesting to see if this impacts on satisfaction with life scores,

gievn the correlation between depression and satisfaction with life (Goverover & Chiaravalloti, 2014; Stalnacke et al., 2007).

In chapter 1, it was hypothesised that demographic variables of age, time since injury and years of education would be significantly correlated with results on neuropsychological tests and questionnaires and that levels of distress would be correlated with results on neuropsychological tests (hypothesis 5). Although levels of distress were not correlated with the main neuropsychological variables, there were significant associations found between participants' distress levels and their self evaluation of cognitive functioning, including the impact that cognitive deficits have on their lives. This is similar to findings reported by Goverover & Chiaravalloti (2014), who found that symptoms of depression were significantly associated with self-reports of poor memory abilities. In this study, correlation analysis revealed that participants who were experiencing higher anxiety, depression and distress levels, evaluated themselves lower in relation to cognition and the impact of cognitive deficits on their lives, at all three timepoints. The provision of CBT as an adjunct to the Cognitive Group Programme may assist individuals who score high on anxiety and depression measures and rate themselves poorly on the Cognitive Self Evaluation questionnaire.

Although previous research (Stalnacke, 2007) has found a strong correlation between depression and life satisfaction, no correlation was found between these two variables in this study. Previous research has also shown a correlation between injury severity and life satisfaction (Wood & Rutterford, 2006a), however no such correlation was observed in this study.

Although it was hypothesised that participation in the Cognitive Group programme would result in significant change for participants in the primary outcome measure of community integration, when compared to a control group ((hypothesis 4), this hypothesis was

not supported, with no significant difference in CIQ scores observed for either group across the three timepoints. From a clinical perspective, the mean score for the intervention group on Total Community Integration increased slightly across each timepoint but remained below normative data levels at T3. Similarly, the mean score for the control group increased slightly across each timepoint on this measure, but remained below normative data levels at T3. Given the limitations of the CIQ measure discussed earlier, it would be beneficial to include significant other ratings and/or other measures of productivity and other aspects of brain injury outcome in a non-self-report format in future studies, as recommended by Goranson et al. (2003). Although previous research has found community integration to be associated with the subjective experience of life satisfaction (Reistetter & Abreu, 2005), there was no significant correlation between these two variables in this study.

In chapter 1, it was hypothesised that participation in the Cognitive Group programme would result in significant change for participants in their knowledge of brain injury when compared to a control group and this change would last beyond the programme (hypothesis 3). On the Knowledge of Brain Injury meaure, there was a significant difference seen in scores for the main effect of time (moderate effect), with scores for the intervention group increasing on this measure at each timepoint whereas scores for the control group increased between T1 and T2 and then decreased slightly at T3. It is encouraging to see the increase in knowledge of brain injury being maintained for the intervention group at T3, indicating that participants retained the knowledge they gained over a 6 month period.

As was observed in this study, participants in wait-list control groups can sometimes demonstrate improved performance on cognitive outcome measures from pretest to posttest, despite not having received the treatment (Rohling et al., 2009). It is likely that practice effects, the benefits of multiple test-taking and placebo effects due to additional

individualised attention received by participation in a research study, contributed to the improvements seen in the control group.

9.10 Recommendations

This study provides some support for the effectiveness of a group-based intervention combining psychoeducation, basic strategy training and stress management techniques for individuals with ABI. The group-based intervention has many practical and economic benefits, with the potential to make neuropsychological rehabilitation accessible to more people as well as providing an opportunity for people with brain injury to learn from and be supported by their peers.

Based on the findings from this study and the current evidence base for neuropsychological rehabilitation, there are a number of steps that could be taken to enhance the ABI Ireland programme, if sufficient resources were available. A more comprehensive form of compensatory strategy training for memory deficits is recommended, to include the use of instructional techniques such as errorless learning, spaced retrieval and use of vanishing cues (Clare & Jones, 2008; Ehlhardt, et al., 2008; Grandmaison & Simard, 2003; Haslam, et al., 2011; Piras et al., 2011). Several studies have demonstrated the importance of incorporating both direct restorative interventions and compensatory strategy training to maximise treatment results in neuropsychological rehabilitation, and to enhance generalisation of learned skills (Meinzer et al., 2005; Poggel et al., 2004; Sohlberg et al., 2003; Tiersky et al., 2005). Dams-O'Connor & Gordon (2013) suggest that bottom-up and top-down training should not be regarded as mutually exclusive, but rather integrated in all training activities. Current research and INCOG guidelines advocate the use of computer-based training programmes as an adjunct to instructional and compensatory strategies for working memory rehabilitation (Nadar & McDowd, 2010; Velikonja et al., 2014) and

therefore this should be considered. The effectiveness of programmes such as CogMed and CogMed QM have shown some promise (Johansson & Tornmalm, 2012; Lundqvist et al., 2010; Westerberg et al., 2007) and therefore could be investigated for inclusion in the programme.

The incorporation of a well recognised metacognitive approach such as Goal Management Training (GMT) would enhance the ABI Ireland programme. Consideration could be given to combining GMT with other training methods, as this approach has been supported by previous research (Krasny-Pacini et al., 2014 Novakovic-Agopian et al., 2011; Miotto et al., 2009; Spikman et al., 2010). One particular treatment that has shown promising results when combined with GMT is Problem Solving Training (PST; Spikman et al., 2010) and therefore this should be considered.

The findings in this study showed some significant improvements in the area of attention for the intervention group, which did not appear to be due to practice effects. In addition to metacognitive strategy training and environmental adaptation, INCOG recommendations include dual task training on individually relevant tasks, Cognitive Behavioural Therapy (CBT) to address interactions between emotion and attention and screening & treatment of sleep disorders that exacerbate attentional problems (Ponsford et al., 2014) and all these treatments could be considered by ABI Ireland as a way to enhance the programme. CBT interventions have the strongest evidence base for improving psychological wellbeing following brain injury (Ownsworth & Gracey, 2017) and it is already used as a treatment by ABI Ireland's Psychology service. CBT could therefore be offered to individuals who are attending the Cognitive Group programme and who are deemed suitable for such an intervention, in order to address emotional issues. This study revealed a significant association found between participants' distress levels and their self evaluation of cognitive functioning, including the impact that cognitive deficits have on their lives. The provision of

CBT may assist individuals who score high on anxiety and depression measures and rate themselves poorly on the Cognitive Self Evaluation questionnaire. However, the provision of CBT would need careful consideration, taking into account limitations on resources. The issue of resources also applies to the provision of dual task training and screening & treatment of sleep disorders if these were to be considered by ABI Ireland.

It is recommended that this current study is continued, in order to increase the sample size and include an equal number of participants in the intervention and control groups. A larger sample size would increase the power of future studies as well as allowing an examination of the individual characteristics that optimise the clinical outcomes of neuropsychological rehabilitation (type of injury, severity, education level etc.). Participants with a mild to moderate brain injury may benefit more from the Cognitive Group intervention, particularly due to the fact that individuals with severe brain injury may not use internal strategies spontaneously outside clinical settings (Velikonja et al., 2014). By increasing the sample size, comparisons can be made between outcomes for those with different levels of injury severity. If changes are made to enhance the Cogntive Group Programme, it is recommended that further research is conducted to evaluate the effectiveness of the enhanced programme

Ratings from significant others would enhance future studies by determining generalisability of improvements to everyday situations. This would support the assessment of community integration, a key outcome measure for neuropsychological rehabilitation. The CIQ questionnaire, which was used in this study, has been described as a 'blunt instrument' Goranson et al. (2003) and therefore significant other ratings would support the use of this self-report measure. Sbordone (2008) emphasises the importance of ecological validity through observing the patient's ability to function outside of the test environment and interviewing significant others to obtain information about the patient functioning at home and in the community, both prior to and following their brain injury. The Mayo-Portland

Adaptability Inventory (MPAI-4; Malec, 2005) could be used to capture ratings from significant others. The MPAI-4 contains three subscales which measure Abilities, Adjustment and Participation. The MPAI-4 was developed specifically for clinical evaluation of individuals during the post-acute period frollowing ABI and has high internal consistency (Cronbach's alpha .89; Malec, Kragness, Evans, Finlay, Kent & Lezak, 2000).

Executive functioning deficits are considered particularly difficult to capture in formal testing (Wall et al., 2013) and there is a growing consensus on the importance of assessing the impact of executive functioning in ecologically-valid environments and to use a real task of everyday life (Poncet, Swaine, Taillefer, Lamoureux, Pradat-Diehl & Chevignard, 2015). Therefore it is recommended that tests with strong ecological validity are considered in future studies when assessing executive functioning, for example the Cooking Task or the Multiple Errands Test (Poncet et al., 2015).

It is also recommended that future studies include scan data, where feasible, in order to support findings from neuropsychological tests and self-report measures. Future studies would also benefit from the inclusion of caregiver assessments on psychosocial measures to determine if participation on the programme by a family member with an ABI has a beneficial impact on family carers.

The inclusion of a qualitative assessment of the programme by participants and facilitators would benefit future studies. A qualitative element to the research could provide insight into the benefits that participants construe from attendance on the programme, reasons for adherence to the programme, as well as any improvements they would recommend. Similary, facilitators could provide valuable insights into the practical side of running the programme, feedback from and interaction with participants, and areas they feel would benefit from improvement. Information captured from participants and facilitators could then

feed into ongoing quality review and support research, thus ensuring continuous improvement of the programme.

Potential confounding variables in studies such as this one include practice effects, benefits of multiple test-taking, placebo effects (due to attention received by participation in a research study), spontaneous neurological recovery and the effect of other treatments and therapies a person may be receiving. In order to take account of pratcice effects, tests which have alternative forms should be considered in any future studies. The CVLT-II test which was used in this study has alternative forms and it is recommended that these are used in future studies. However, alternative forms are not always available and therefore another recommended approach is to include two or more baseline assessments before introducing the main assessments (McCaffrey and Westervelt, 1995). This approach would also take account of participants who learn to use an effective test-taking strategy or have acquired 'test-wiseness' (Beglinger et al., 2005). In order to take account of the potential for spontaneous recovery during the study period, it is recommended that those who acquired their brain injury within the previous twelve months are excluded from future studies. Although information was captured concerning services that participants were receiving at the time of the study, more detailed information was not obtained regarding numbers of contact hours with a Neurorehabilitation Assistant/ Clinical Psychologist or types of teratments received (for example CBT) etc. It is recommended that this detailed type of information is captured so that these confounding variables can be adequately controlled for in future studies.

The ABI Ireland Cognitive Group Programme is currently run in Dublin and Sligo. It is recommended that following enhancement of the programme as recommended above, it is extended beyond these areas, to include other regions and other community brain injury service providers. It is important to ensure fidelity to the programme and therefore a 'train the

trainer' format is recommended to ensure programme consistency in other locations and organisations.

9.11 Limitations

One of the limitations of the study is the relatively small sample size (*n*=32), as a larger sample size would have increased the power of the study. At the outset of the study, the aim was to recruit between 60-70 participants, however this number was not achieved due to the number of programmes that were run during the course of the research study, the numbers of people who expressed an interest in taking part in the study and an attrition rate of 18%. There were nineteen participants in the intervention arm and thirteen in the control arm of the study and due to the different participant numbers in each group, non-parametric tests were used for some of the statistical analyses. If there had been an even number of participants in each group, parametric alternative tests could have been used which would have been preferable as they are more powerful.

Scan data for participants was not available and this is a limitation of the study. The inclusion of scan data can support findings from neuropsychological tests and self-report measures. Also, the inclusion of a qualitative assessment of the programme by participants and facilitators would have benefited this study by providing insight into the benefits for participants that may not have been captured through tests and questionnaires.

Potential confounding variables in the study include practice effects, benefits of multiple test-taking, placebo effects (due to attention received by participation in a research study), spontaneous neurological recovery and the effect of other treatments and therapies a person may be receiving. In relation to practice effects, memory tests in particular are influenced by practice effects (Benedict & Zgaljardic, 1998; Wilson et al., 2000) and the greatest practice effects are likely to occur between the first and second examinations on

many tests (Benedict & Zgaljardic, 1998; Ivnik et al., 1999). The tests used in this study which are considered most vulnerable to practice effects are the California Verbal Learning Test-Second Edition (CVLT-II) and the Trail Making test. The CVLT (Delis et al., 1987) has been shown to be vulnerable to significant practice effects in a psychiatric population (Hawkins & Wexler, 1999) and a HIV-infected population (Duff et al., 2001) and the various versions of the Trail Making Test have been found to be vulnerable to practice effects (Buck et al., 2008; Homack et al., 2005; Naglieri & Das, 1997; Reynolds, 2002). Therefore, caution has been exercised in the interpretation of test results for these two measures.

In addition to practice effects, there can be a general test-taking benefit in which enhanced performance may occur after repeated examinations, due to a participant feeling less anxious on the second or third time of testing as they become more familiar with the examiner and procedures. Therefore significant results observed on neuropsychological tests, in particular between T1 and T2, should be interpreted with caution.

As was observed in this study, participants in wait-list control groups can sometimes demonstrate improved performance on cognitive outcome measures from pretest to posttest, despite not having received the treatment (Rohling et al., 2009). One explanation for this is placebo effects, due to additional individualised attention received by participation in a research study (Rohling et al., 2009). These placebo effects can also influence the performance of intervention group participants and is a factor that should be considered when interpreting results for either group.

Another potential confounding variable is spontaneous neurological recovery during the study period (Rohling et al., 2009). A meta-analysis conducted by Elliott & Parente (2014) of memory rehabilitation therapy found that significant memory improvement occurred spontaneously over time. Spontaneous recovery is more likely to occur within one

year post-injury (Cope, 1995) and two of the intervention group participants had acquired their brain injury within the previous twelve months.

As part of this study, participants completed questionnaires in relation to anxiety, depression, satisfaction with life, community integration, cognitive self-evaluation and knowledge of brain injury. Often individuals with a brain injury lack awareness or insight into their deficits (known as anosognosia) and therefore the use of self-report questionnaires could be a possible limitation. However, in general, participants in this study demonstrated good insight in discussing the problems and challenges they face in everyday life with the author. Participants also demonstrated good insight when noting the cognitive deficits they experience, and the impct it has on their lives, when completing the cognitive group self evaluation questionnaire. McBrinn et al. (2008) found that people with brain injury who had better awareness of their difficulties had higher emotional distress, regardless of time since injury. It is interesting to note that levels of distress were higher than normative data levels at all three timepoints for both groups, indicating that participants probably had good awareness and insight into their deficits.

Although random assignment to intervention and control groups is the preferred option, this was not possible for this particular study due to practical issues around participant recruitment. This is not seen as a major limitation for the study as it is well recognised that RCT studies are difficult to conduct in most rehabilitation settings and are rare (Carney, et al., 1999). Goranson et al. (2003) highlight that studies that use sample sizes of at least twenty and no-treatment control groups, even if non-randomized, would be especially beneficial when evaluating the effectiveness of rehabilitation programmes.

The majority of participants (74%) in the intervention group had severe brain injuries and this may be a factor in the lack of change seen on the community integration measure across the three timepoints. The Cognitive Programme involves a significant amount of input

from the individual and those with severe memory and/ or executive impairments may be less able to implement internal strategies. Future studies that include more people with moderate and mild brain injuries would be of interest.

Another limitation of the current study is the heterogeneity of participants in terms of cause of injury. Participants included those with traumatic and non-traumatic brain injuries (including cerebrovascular accidents and brain injuries acquired through cardiac arrest, brain tumour, meningitis, diabetic coma, seizure and encephalitis). This makes it difficult to generalise findings for particular ABI sub-groups. If future studies involve a larger sample size, this will allow an examination of the individual characteristics that optimise the clinical outcomes of neuropsychological rehabilitation (type of injury, severity, education level etc.).

Information was captured in relation to ABI services that participants, from both groups, were accessing. Both groups had similar numbers of participants accessing Assisted Living Services, with 16% in the intervention group and 15% in the control group accessing this type of service. The percentage of participants accessing a community outreach service was higher in the control group (46%) than the intervention group (32%) and the percentage of participants accessing a case management service was higher in the intervention group (26%) than the control group (8%). Only one person from each group fell into the 'ABI Ireland Psychology service only' category and three control group participants were not accessing any service. Access to services such as assisted living and comunity outreach can include activities in goal setting & management as part of Individual Rehabilitation Plans (IRPs), and therefore introduces many mediating variables into this study. Similarly, access to an ABI Ireland Psychologist may include Cognitive Behavioural Therapy (CBT) or other forms of therapy, and this also introduces many mediating variables into this study. For this reason, caution should be used when interpreting findings in this study. Although it was not feasible to control for all the mediating variables in this study, it is recommended for future

studies that more detailed information is captured in relation to services accessed, including number of hours of therapy, number of contact hours by a Neurorehabilitation Assistant etc. This will ensure that mediating variables can be adequately controlled for in future studies.

9.12 Conclusion

Group-based interventions have become more prevalent in healthcare environments over the last number of decades, given their practical and economic benefits (Patterson et al., 2016). However, there is currently a lack of research investigating the effects of group-based neuropsychological rehabilitation programmes for individuals with ABI. This study provides some support for the effectiveness of such a programme. These findings have important implications for neurorehabilitation service providers, as well as being of interest to individuals with an ABI and their families. The study provides an opportunity for investigating further the potential for interventions that combine psychoeducation, basic strategy training for cognitive deficits and stress management techniques in a group setting, for individuals with an ABI.

Some significant improvements were seen in the intervention group on neuropsychological tests measuring attention, memory, visual scanning and cognitive flexibility. However, these findings should be interpreted cautiously as practice effects, the general benefit of multiple test-taking and placebo effects may have influenced results. The primary outcome measure for this study is community integration, however no significant difference was seen on this measure for the intervention group across the three timepoints. The addition of significant other ratings would strengthen future studies by determining generalisability of improvements to everyday situations.

Costs of morbidity due to brain injury are incurred by the healthcare system and those outside it (in terms of loss of productivity due to short-term sick leave and early retirement),

and through non-medical costs (for example, transformations of house or work environments, etc.; das Nair et al., 2015). In addition, informal care by family or friends can dominate the costs of care for affected individuals. Wilson (2017) argues that we need to persuade health care purchasers that rehabilitation makes clinical and economic sense and Prigatano (2013) suggests that doing long-term cost-benefit analysis of neuropsychological rehabilitation is absolutely necessary in the economic times in which we live. Adequate funding is often not made available for the best rehabilitation for individuals with brain injury. This study adds to the research base for the effectiveness of group-based interventions and it is vital that sufficient funding is made available so that these types of cost-effective interventions can be made available to the people who will most benefit from them.

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APPENDICES

Appendix A: California Verbal Learning Test-Second Edition (CVLT-II)

Appendix B: Trail Making Test

Appendix C: Sustained Attention Response Task Instructions

Appendix D: Digit Span Test

Appendix E: Community Integration Questionnaire

Appendix F: The Satisfation with Life Scale

Appendix G: Hospital Anxiety and Depression Scale

Appendix H: Cognitive Group Self-Evaluation Questionnaire

Appendix I: Knowledge of Brain Injury Questionnaire

Appendix J: Ethics Committee Approval

Appendix K: Participant advertisement and information sheet

Appendix L: Consent Form

Appendix A: California Verbal Learning Test-Second Edition (CVLT-II)

CVLT-II UK California Verbal Learning Test UK–Second Edition

Dean C. Delis Joel H. Kramer Edith Kaplan Beth A. Ober

California Verbal Learning Test® Second Edition • Adult Version

Standard Form

Name: _____ ID#: _____ Examiner: _____

Sex: ☐ F ☐ M Race/Ethnicity: _____ Education (years): _____

Handedness: ☐ R ☐ L ☐ Ambidextrous Hearing adequate? ☐ Y ☐ N Hearing aid? ☐ Y ☐ N

First language: _____ Preferred language: _____ Effort appear adequate? ☐ Y ☐ ? ☐ N

Affect and mood: _____ Physical appearance: _____

Other behaviours: _____

Major complaints: _____

Diagnostic history: _____

Current medications: _____

	Date Tested	Year	Month	Day
	Date of Birth			
	Age at Testing			

	Raw Score	Standard Score
Trial 1 Free Recall Correct		
Trial 2 Free Recall Correct		
Trial 3 Free Recall Correct		
Trial 4 Free Recall Correct		
Trial 5 Free Recall Correct		
Trials 1–5 Free Recall Total Correct	(T score)	
List B Free Recall Correct		
Short-Delay Free Recall Correct		
Short-Delay Cued Recall Correct		

	Raw Score	Standard Score
Long-Delay Free Recall Correct		
Long-Delay Cued Recall Correct		
Free-Recall Intrusions (Immediate & Delayed, All Types)		
Cued-Recall Intrusions (All Types)		
Total Intrusions (All Recall Trials, All Types)		
Total Repetitions (All Recall Trials)		
Long-Delay Yes/No Recognition Hits		
Long-Delay Yes/No Recognition False-Positives		
Long-Delay Forced-Choice Recognition Accuracy (# hits ____ /16) x 100	%	

PEARSON

List A Immediate Free Recall Trial 1

I'm going to read a list of words to you. Listen carefully, because when I'm through, I want you to tell me as many of the words as you can. You can say them in any order, just say as many of them as you can. Are you ready?

Read List A at an even pace, taking slightly longer than one second per word, so the entire list takes 18 to 20 seconds. Then say: **Go ahead.**

Trial 2

I'm going to read the same list again. Like before, tell me as many of the words as you can, in any order. Be sure to also say words from the list that you told me the first time.

Trials 3 and 4

I'm going to read the same list again. Like before, tell me as many of the words as you can, in any order, including words from the list you've said before.

Trial 5

I'm going to read the same list one more time. Like before, tell me as many of the words as you can, in any order, including words from the list you've said before.

Record all responses verbatim, in the order recalled. Prompt only once (e.g., Anything else?) at the end of each free and cued recall trial (i.e., after 15 seconds with no response or when the examinee says he/she cannot remember more words).

List A
truck
spinach
giraffe
bookcase
onion
motorcycle
cabinet
zebra
coach
lamp
celery
cow
desk
boat
squirrel
cabbage

	Trial 1	Resp Type	Trial 2	Resp Type	Trial 3	Resp Type	Trial 4	Resp Type	Trial 5	Resp Type
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
Total Correct	C		C		C		C		C	
Total Repetitions	R		R		R		R		R	
Total Intrusions	I		I		I		I		I	

List B Immediate Free Recall

Now I'm going to read a second list of words to you. When I'm through, I want you to tell me as many words from this second list as you can, in any order. Don't tell me words from the first list, just this second list.

Read List B at an even pace, taking slightly longer than one second per word, so the entire list takes 18 to 20 seconds. Then say: **Go ahead.**

List A Short-Delay Free Recall

Now I want you to tell me all the words you can from the first list, the one I read to you several times. Don't tell me words from the second list, just the first list. Go ahead.

List A Short-Delay Cued Recall

Tell me all the words from the first list that are furniture.
Tell me all the words from the first list that are vegetables.
Tell me all the words from the first list that are ways of traveling.
Tell me all the words from the first list that are animals.

Record all responses verbatim, in the order recalled. Prompt only once (e.g., Anything else?) at the end of each free and cued recall trial (i.e., after 15 seconds with no response or when the examinee says he/she cannot remember more words).

List B
violin
cucumber
elephant
attic
turnip
guitar
basement
sheep
clarinet
garage
corn
rabbit
patio
saxophone
tiger
radishes

	Trial B	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Total Correct C ☐
Total Repetitions R ☐
Total Intrusions I ☐

	List A	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Total Correct C ☐
Total Repetitions R ☐
Total Intrusions I ☐

	Furniture	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		

	Vegetables	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		

	Ways of Traveling	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		

	Animals	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		

Total Correct C ☐
Total Repetitions R ☐
Total Intrusions I ☐

There should be approximately a ***20-minute delay*** *between the completion of Short-Delay Cued Recall and the start of Long-Delay Free Recall. Do not inform the examinee that there will be later CVLT-II trials.*

List A Long-Delay Free Recall

I read two different lists of words to you earlier: a first list that I read to you several times, and a second list that I read to you once. Tell me all the words you can that were from the first list. Don't tell me words from the second list, just the first list. Go ahead.

	List A	Resp Type
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Total Correct C ☐
Total Repetitions R ☐
Total Intrusions I ☐

List A Long-Delay Cued Recall

Tell me all the words from the first list that are furniture.
Tell me all the words from the first list that are vegetables.
Tell me all the words from the first list that are ways of traveling.
Tell me all the words from the first list that are animals.

	Furniture	Resp Type	Vegetables	Resp Type	Ways of Traveling	Resp Type	Animals	Resp Type
1			1		1		1	
2			2		2		2	
3			3		3		3	
4			4		4		4	
5			5		5		5	
6			6		6		6	
7			7		7		7	
8			8		8		8	

Total Correct C ☐ Total Repetitions R ☐ Total Intrusions I ☐

List A Long-Delay Yes/No Recognition

Now I'm going to read more words to you. After I read each one, say 'Yes' if that word was from the first list, or say 'No' if it was not from the first list.

If the examinee responds 'I don't know' during Yes/No Recognition, say, 'Tell me whether you think was on the first list.'

	Response		Item Type		Response		Item Type		Response		Item Type		Response		Item Type
wallet	Y	N	UN	violin	Y	N	BN	dog	Y	N	PR	turnip	Y	N	BS
boat	Y	N	T	**cow**	Y	N	T	**bookcase**	Y	N	T	**cabinet**	Y	N	T
saxophone	Y	N	BN	fork	Y	N	UN	matches	Y	N	UN	**onion**	Y	N	T
cucumber	Y	N	BS	bus	Y	N	PR	**spinach**	Y	N	T	lion	Y	N	PR
giraffe	Y	N	T	**celery**	Y	N	T	clarinet	Y	N	BN	camera	Y	N	UN
carrot	Y	N	PR	**lamp**	Y	N	T	**truck**	Y	N	T	guitar	Y	N	BN
patio	Y	N	BN	radishes	Y	N	BS	rabbit	Y	N	BS	**coach**	Y	N	T
cabbage	Y	N	T	table	Y	N	PR	chair	Y	N	PR	tiger	Y	N	BS
desk	Y	N	T	rose	Y	N	UN	corn	Y	N	BS	coffee	Y	N	UN
bracelet	Y	N	UN	**motorcycle**	Y	N	T	seashell	Y	N	UN	**zebra**	Y	N	T
car	Y	N	PR	sheep	Y	N	BS	garage	Y	N	BN	lettuce	Y	N	PR
elephant	Y	N	BS	basement	Y	N	BN	**squirrel**	Y	N	T	attic	Y	N	BN

T = Target
Distractor Types: BS = List B Shared; BN = List B Non-Shared; PR = Prototypical; UN = Unrelated

*There should be approximately a **10-minute delay** between the completion of Yes/No Recognition and the start of Forced-Choice Recognition. Do not inform the examinee that there will be a later CVLT-II trial.*

Total Hits ☐
Total False-Positives ☐

List A Long-Delay Forced-Choice Recognition (Optional)

Earlier, I read some lists of words to you, remember? Now I am going to read some words two at a time. After I read both words, say which of the words was from the first list, the one I read to you several times. It may be difficult to remember which one to pick, but even if it's hard for you, just try your best. Ready?

Was boat or flag on the first list?

Was ____ or ____ on the first list?

Circle the examinee's responses.

> *If the examinee says 'I don't know,' say, 'I know it may be difficult, but just take your best guess.'*

			Score (1 or 0)	Dist. type
boat	or	flag		C
cake	or	**desk**		C
majority	or	**cow**		A
celery	or	aspirin		C
bookcase	or	silence		A
blender	or	**truck**		C
onion	or	logic		A
football	or	**zebra**		C
instruction	or	**cabinet**		A
squirrel	or	direction		A
blanket	or	**cabbage**		C
coach	or	technique		A
height	or	**spinach**		A
giraffe	or	towel		C
subject	or	**motorcycle**		A
lamp	or	sprinkler		C

Distractor types: C = concrete; A = abstract Total Hits ☐

Total Accuracy: (____ /16) x 100 = ____ %

Notes: _____

Appendix B: Trail Making Test

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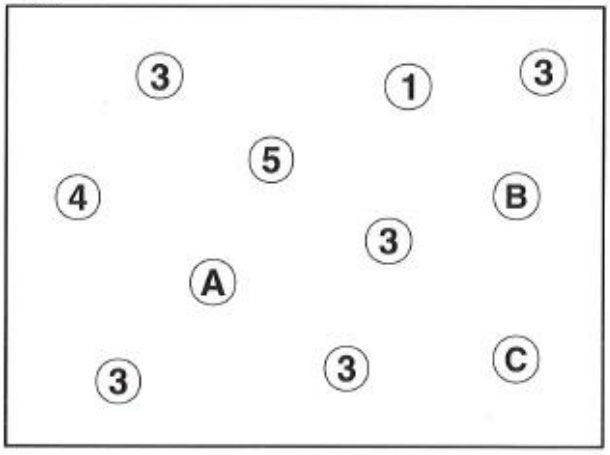
D·KEFS
Executive Function System™

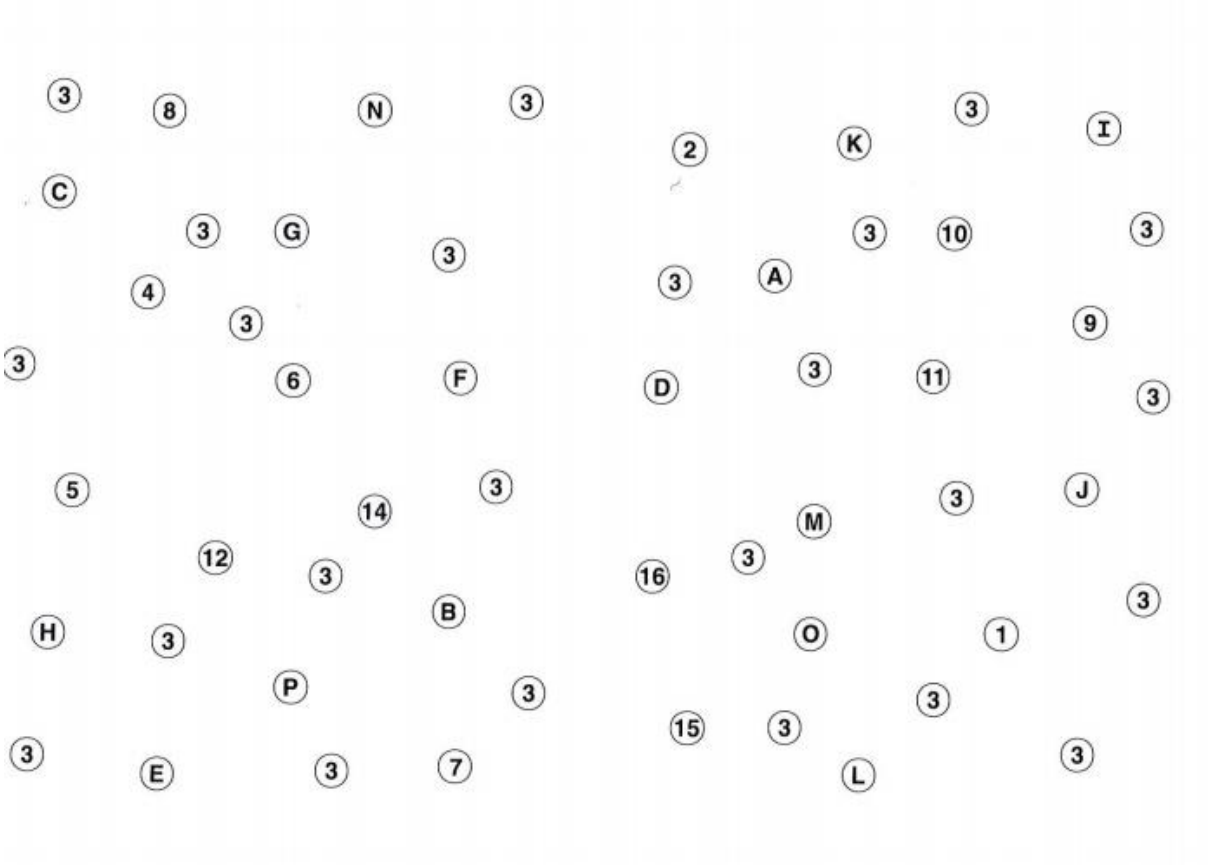
Name _____ Age _____
ID _____ Date _____
Examiner _____
Notes _____

Trail Making Test

Condition 1
Visual Scanning

Practice




3
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L

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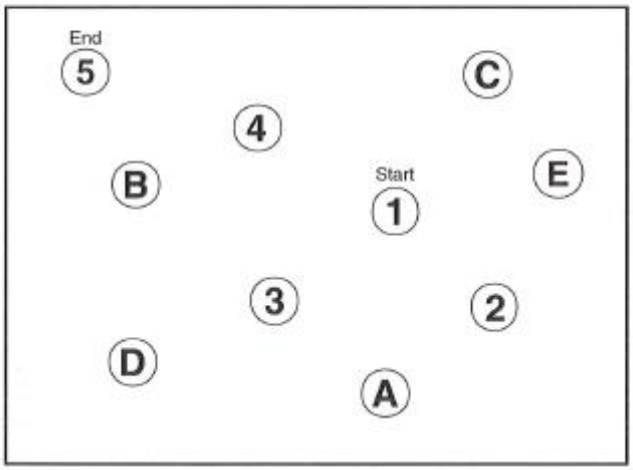
D·KEFS
Executive Function System

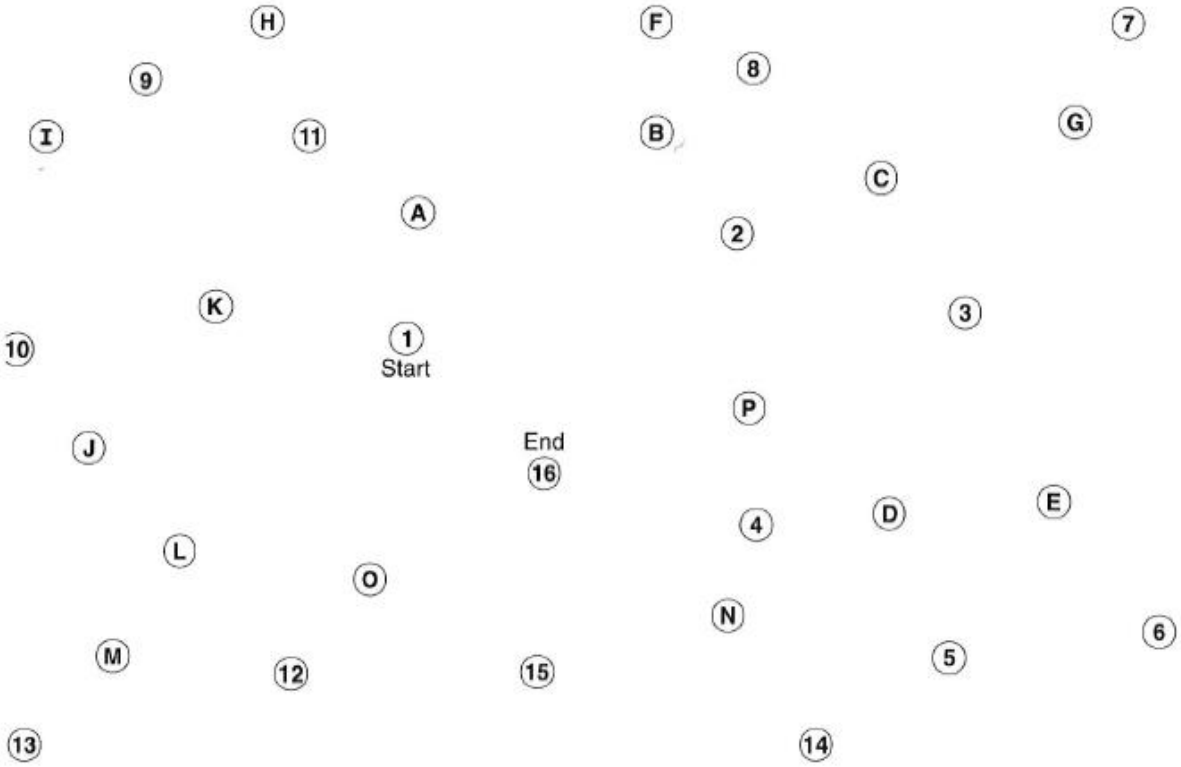
Name _____ Age _____
ID _____ Date _____
Examiner _____
Notes _____

Trail Making Test

Condition 2
Number Sequencing

Practice

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L
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M
5
12
15
13
14

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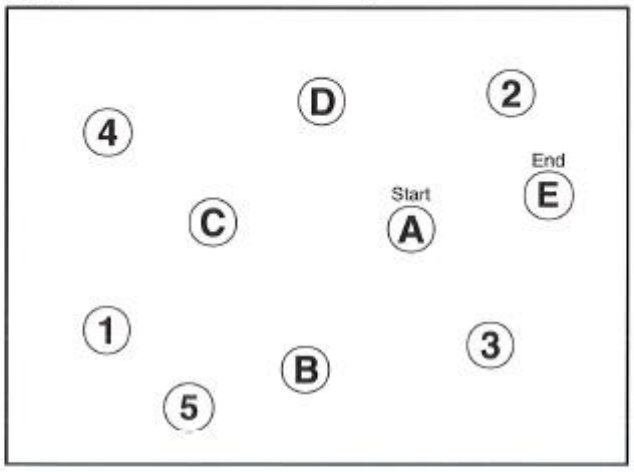
D·KEFS
Executive Function System

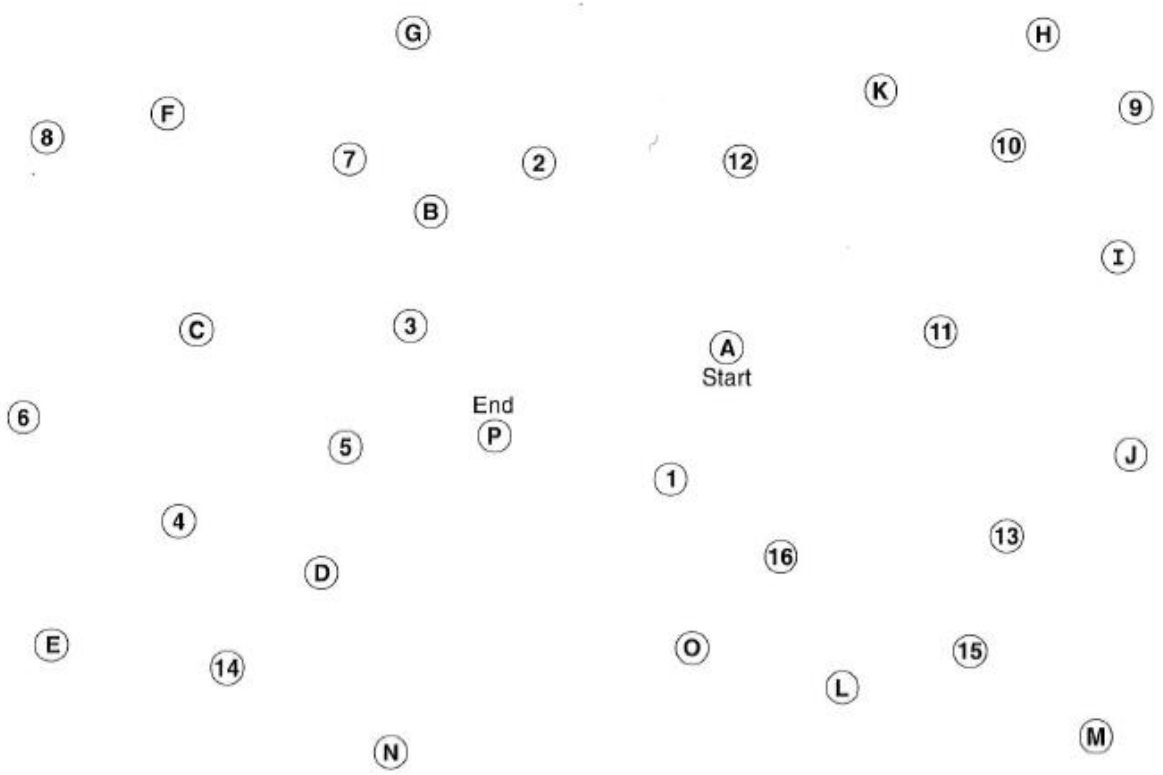
Name _____ Age _____
ID _____ Date _____
Examiner _____
Notes _____

Trail Making Test

Condition 3
Letter Sequencing

Practice

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N

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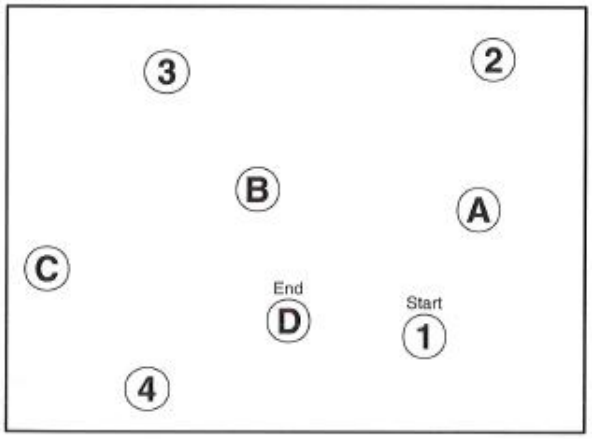
Executive Function System

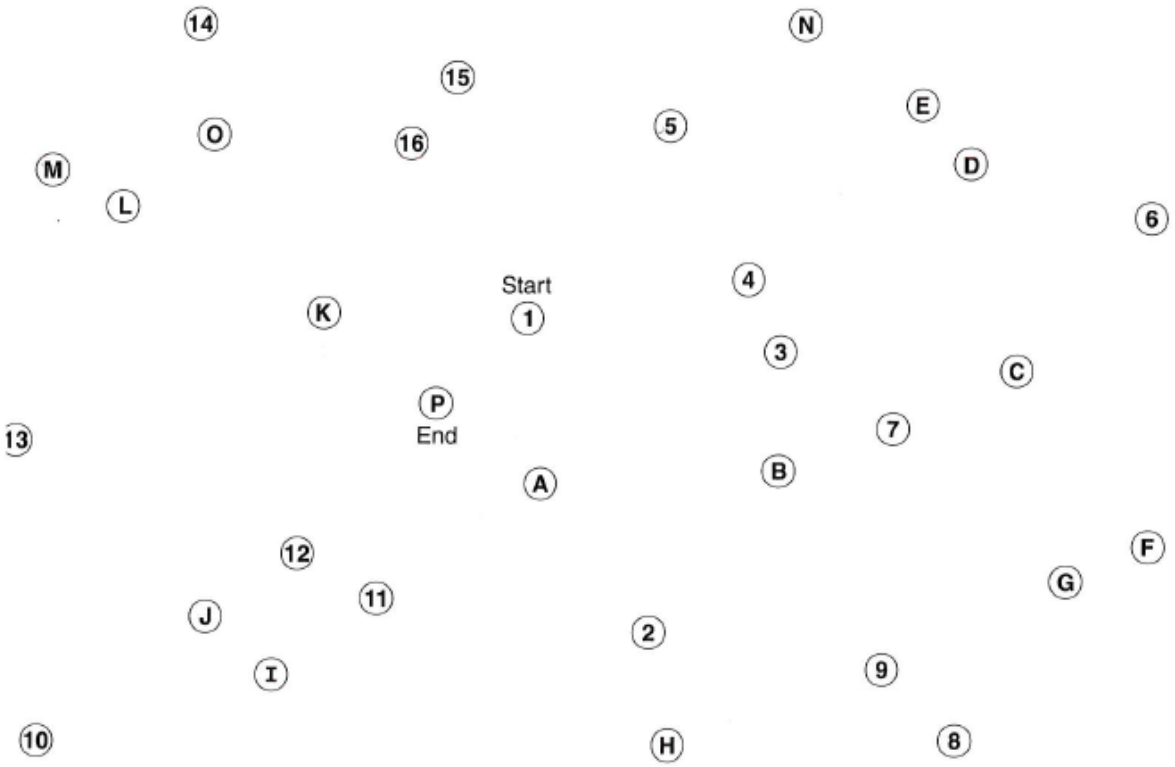
Name _____ Age _____
ID _____ Date _____
Examiner _____
Notes _____

Trail Making Test

Condition 4
Number–Letter Switching

Practice

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8

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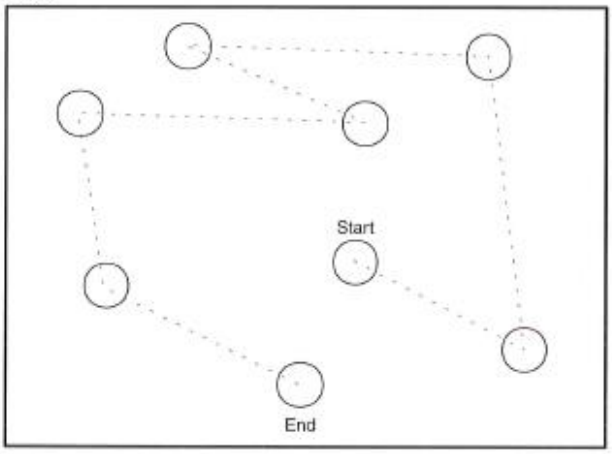
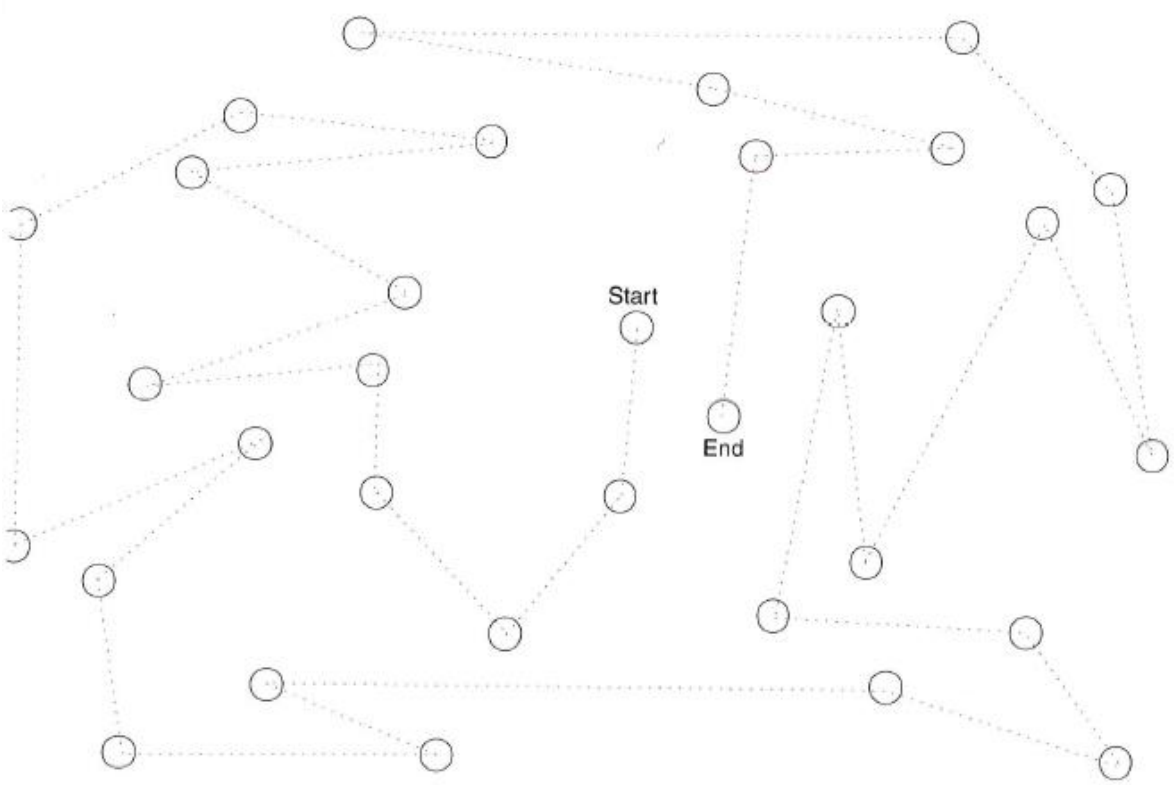
Trail Making Test

Name _____ Age _____
ID _____ Date _____
Examiner _____
Notes _____

Condition 5
Motor Speed

Practice




Start
End

Appendix C: Sustained Attention Response Task Instructions

This test is run on a computer. Participants were presented with the following instructions:

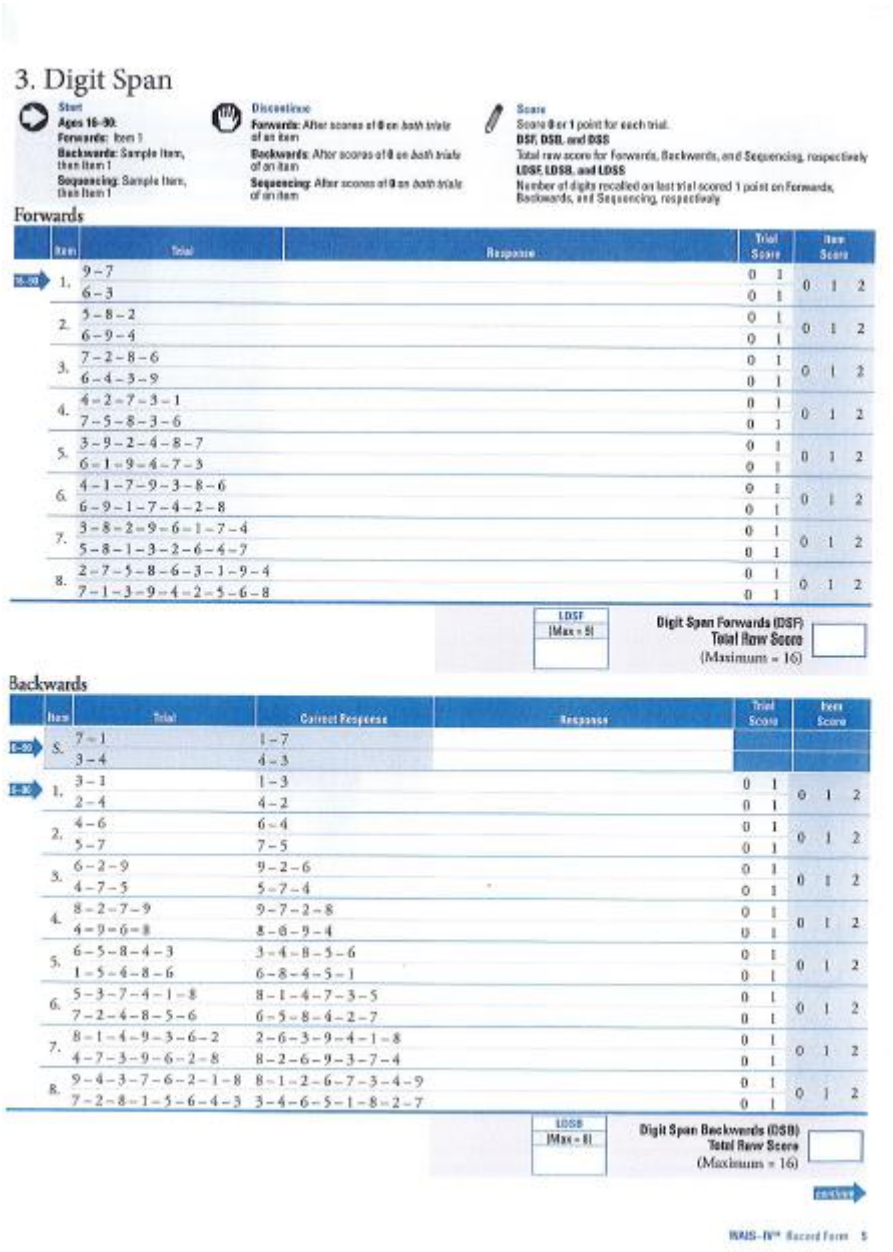
Screen 1: During this experiment you will see a seies of numbers (between 1 and 9) appear on the screen. The numbers will appear one at a time and be separated by a screen with a cross.
Please press the spacebar to continue.

Screen 2: You must press the button on the mouse every time you see a number. You must NOT press the button everytime you see a 3.
Once you are sure you understand the instructions please press the spacebar to begin a practice trial.

[Practice Trial]

Screen 3: End of Practice Trial
If you are confident you understand the task please press the spacebar to continue.

Appendix D: Digit Span Test



3. Digit Span

Start
Ages 16–90:
Forwards: Item 1
Backwards: Sample Item, then Item 1
Sequencing: Sample Item, then Item 1

Discontinue
Forwards: After scores of 0 on both trials of an item
Backwards: After scores of 0 on both trials of an item
Sequencing: After scores of 0 on both trials of an item

Score
Score 0 or 1 point for each trial.
DSF, DSB, and DSS
Total raw score for Forwards, Backwards, and Sequencing, respectively
LDSF, LDSB, and LDSS
Number of digits recalled on last trial scored 1 point on Forwards, Backwards, and Sequencing, respectively

Forwards

	Item	Trial	Response	Trial Score	Item Score
16–90	1.	9 – 7		0 1	0 1 2
		6 – 3		0 1	
	2.	5 – 8 – 2		0 1	0 1 2
		6 – 9 – 4		0 1	
	3.	7 – 2 – 8 – 6		0 1	0 1 2
		6 – 4 – 3 – 9		0 1	
	4.	4 – 2 – 7 – 3 – 1		0 1	0 1 2
		7 – 5 – 8 – 3 – 6		0 1	
	5.	3 – 9 – 2 – 4 – 8 – 7		0 1	0 1 2
		6 – 1 – 9 – 4 – 7 – 3		0 1	
	6.	4 – 1 – 7 – 9 – 3 – 8 – 6		0 1	0 1 2
		6 – 9 – 1 – 7 – 4 – 2 – 8		0 1	
	7.	3 – 8 – 2 – 9 – 6 – 1 – 7 – 4		0 1	0 1 2
		5 – 8 – 1 – 3 – 2 – 6 – 4 – 7		0 1	
	8.	2 – 7 – 5 – 8 – 6 – 3 – 1 – 9 – 4		0 1	0 1 2
		7 – 1 – 3 – 9 – 4 – 2 – 5 – 6 – 8		0 1	

LDSF (Max = 8)

Digit Span Forwards (DSF) Total Raw Score (Maximum = 16)

Backwards

	Item	Trial	Correct Response	Response	Trial Score	Item Score
8–90	S.	7 – 1	1 – 7			
		3 – 4	4 – 3			
2–90	1.	3 – 1	1 – 3		0 1	0 1 2
		2 – 4	4 – 2		0 1	
	2.	4 – 6	6 – 4		0 1	0 1 2
		5 – 7	7 – 5		0 1	
	3.	6 – 2 – 9	9 – 2 – 6		0 1	0 1 2
		4 – 7 – 5	5 – 7 – 4		0 1	
	4.	8 – 2 – 7 – 9	9 – 7 – 2 – 8		0 1	0 1 2
		4 – 9 – 6 – 8	8 – 6 – 9 – 4		0 1	
	5.	6 – 5 – 8 – 4 – 3	3 – 4 – 8 – 5 – 6		0 1	0 1 2
		1 – 5 – 4 – 8 – 6	6 – 8 – 4 – 5 – 1		0 1	
	6.	5 – 3 – 7 – 4 – 1 – 8	8 – 1 – 4 – 7 – 3 – 5		0 1	0 1 2
		7 – 2 – 4 – 8 – 5 – 6	6 – 5 – 8 – 4 – 2 – 7		0 1	
	7.	8 – 1 – 4 – 9 – 3 – 6 – 2	2 – 6 – 3 – 9 – 4 – 1 – 8		0 1	0 1 2
		4 – 7 – 3 – 9 – 6 – 2 – 8	8 – 2 – 6 – 9 – 3 – 7 – 4		0 1	
	8.	9 – 4 – 3 – 7 – 6 – 2 – 1 – 8	8 – 1 – 2 – 6 – 7 – 3 – 4 – 9		0 1	0 1 2
		7 – 2 – 8 – 1 – 5 – 6 – 4 – 3	3 – 4 – 6 – 5 – 1 – 8 – 2 – 7		0 1	

LDSB (Max = 8)

Digit Span Backwards (DSB) Total Raw Score (Maximum = 16)

continue

WAIS-IV™ Record Form 5

3. Digit Span *(continued)*

Sequencing

Discontinue after scores of 0 on both trials of an ite

	Item	Trial	Correct Response	Response	Trial Score	Item Score
16–90	S.	2–3–1	1–2–3			
		5–2–2	2–2–5			
16–90	1.	1–2	1–2		0 1	0 1 2
		6–2	2–4		0 1	
	2.	3–1–6	1–3–6		0 1	0 1 2
		0–9–4	0–4–9		0 1	
	3.	8–7–9–2	2–7–8–9		0 1	0 1 2
		4–8–7–1	1–4–7–8		0 1	
	4.	2–6–9–1–7	1–2–6–7–9		0 1	0 1 2
		3–8–3–5–8	3–3–5–8–8		0 1	
	5.	2–1–7–4–3–6	1–2–3–4–6–7		0 1	0 1 2
		6–2–5–2–3–4	2–2–3–4–5–6		0 1	
	6.	7–5–7–6–8–6–2	2–5–6–6–7–7–8		0 1	0 1 2
		4–8–2–5–4–3–5	2–3–4–4–5–5–8		0 1	
	7.	5–8–7–2–7–5–4–5	2–4–5–5–5–7–7–8		0 1	0 1 2
		9–4–9–7–3–0–8–4	0–3–4–4–7–8–9–9		0 1	
	8.	5–0–1–1–3–2–1–0–5	0–0–1–1–1–2–3–5–5		0 1	0 1 2
		2–7–1–4–8–4–2–9–6	1–2–2–4–4–6–7–8–9		0 1	

LDSS (Max = 9)

Digit Span Sequencing (DSS) Total Raw Score (Maximum = 16)

Digit Span Total Raw Score (Maximum = 48)

Appendix E: Community Integration Questionnaire

COMMUNITY INTEGRATION QUESTIONNAIRE

Subject: _____ **Date:** _____

1. Who usually does the shopping for groceries or other necessities in your household?	○ Yourself alone ○ Yourself and someone else ○ Someone else
2. Who usually prepares meals in your household?	○ Yourself alone ○ Yourself and someone else ○ Someone else
3. In your home who usually does the everyday housework?	○ Yourself alone ○ Yourself and someone else ○ Someone else
4. Who usually cares for the children in your home?	○ Yourself alone ○ Yourself and someone else ○ Someone else ○ Not applicable, No children under 17 in the home
5. Who usually plans social arrangements such as get-togethers with family and friends?	○ Yourself alone ○ Yourself and someone else ○ Someone else
6. Who usually looks after your personal finances, such as banking or paying bills?	○ Yourself alone ○ Yourself and someone else ○ Someone else
7. Approximately how many times a month do you usually participate in shopping *outside* your home?	○ Never ○ 1 - 4 times ○ 5 or more
8. Approximately how many times a month do you usually participate in leisure activities such as movies, sports, restaurants, etc.	○ Never ○ 1 - 4 times ○ 5 or more
9. Approximately how many times a month do you usually visit your friends or relatives?	○ Never ○ 1 - 4 times ○ 5 or more
10. When you participate in leisure activities do you usually do this alone or with others?	○ Mostly alone ○ Mostly with friends who have head injuries ○ Mostly with family members ○ Mostly with friends who do not have head injuries ○ With a combination of family and friends

Please complete page two

COMMUNITY INTEGRATION QUESTIONNAIRE (Page 2)

11. Do you have a best friend with whom you confide?	○ Yes ○ No
12. How often do you travel outside the home?	○ Almost every day ○ Almost every week ○ Seldom/never (less than once per week)
13. Please choose the answer that best corresponds to your current (during the past month) work situation:	○ Full-time (more than 20 hours/week) ○ Part-time (less than or equal to 20 hrs/week) ○ Not working, but actively looking for work ○ Not working, not looking for work ○ Not applicable, retired due to age
14. Please choose the answer that best corresponds to your current (during the past month) school or training program situation:	○ Full-time ○ Part-time ○ Not attending school, or training program ○ Not applicable, retired due to age
15. In the past month, how often did you engage in volunteer activities?	○ Never ○ 1 - 4 times ○ 5 or more

Comments:

Appendix F: Satisfaction with Life Scale

Below are five statements with which you may agree or disagree.
Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding. The 7-point scale is as follows:

- 1 - Strongly disagree
- 2 - Disagree
- 3 - Slightly disagree
- 4 - Neither agree nor disagree
- 5 - Slightly agree
- 6 - Agree
- 7 - Strongly agree

____ In most ways my life is close to my ideal.

____ The conditions of my life are excellent.

____ I am satisfied with my life.

____ So far I have gotten the important things I want in life.

____ If I could live my life over, I would change almost nothing.

Appendix G: Hospital Anxiety and Depression Scale

Hospital Anxiety and Depression Scale

This questionnaire is designed to help you state how you have been feeling over the past week. Please read each item and **underline** the reply which comes closest to how you have been feeling in the past week.

1. I feel tense or wound up:
Most of the time
A lot of the time
From time to time, occasionally
Not at all

2. I still enjoy the things I used to:
Definitely as much
Not quite so much
Only a little
Hardly at all

3. I get a sort of frightened feeling as if something awful is about to happen:
Very definitely and quite badly
Yes, but not too badly
A little, but it doesn't worry me
Not at all

4. I can laugh and see the funny side of things:
As much as I always could
Not quite so much now
Definitely not so much now
Not at all

5. Worrying thoughts go through my mind:
A great deal of the time
A lot of the time
From time to time but not too often
Only occasionally

6. I feel cheerful:
Not at all
Not often
Sometimes
Most of the time

7. I can sit at ease and feel relaxed:
Definitely
Usually
Not often
Not at all

8. I feel as if I am slowed down:
Nearly all the time
Very often
Sometimes
Not at all

9. I get a sort of frightened feeling like 'butterflies' in the stomach:
Not at all
Occasionally
Quite often
Very often

10. I have lost interest in my appearance:
Definitely
I don't take as much care as I should
I may not take quite as much care
I take just as much care as ever

11. I feel restless as if I have to be on the move:
Very much indeed
Quite a lot
Not very much
Not at all

12. I look forward with enjoyment to things:
As much as I ever did
Rather less than I used to
Definitely less than I used to
Hardly at all

13. I get sudden feelings of panic:
Very often indeed
Quite often
Not very often
Not at all

14. I can enjoy a good book or radio or TV:
Often
Sometimes
Not often
Very seldom

Appendix H: Cognitive Group Self Evaluation Questionnaire

Cognitive Group Self Evaluation Form

Recognising the cognitive changes you may be experiencing after head injury is an important part of your rehabilitation.

Understanding how these changes may effect the way you perform everyday activities is not always easy.

When you recognise and understand any cognitive difficulties you may be experiencing it becomes that much easier to work out practical methods and strategies that will help you cope or manage these changes more effectively.

The following changes are designed to make you think about how well you perform some everyday activities now. They are areas that clients most commonly report to therapists as problematic.

Think carefully about your answers.
Then circle a number from 0 – 5 on the scale which is below each question.

Where 0 is no difficulty and 5 is severe difficulty.

Name: **Date:**

Q1: Do you feel you have any difficulties writing down messages / important information while you are talking to someone on the telephone?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q2: Do you feel you have any difficulties concentrating on an activity when other things are going on around you (for example music from a radio, conversations from other people, children playing)?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q3: Do you feel you have any difficulties remembering appointments?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q4: Do you feel that you have any difficulties remembering conversations you have had with others?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q5: Do you feel you have had any difficulties planning small projects (for example planning a party, a holiday etc.)?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q6: Do you feel you have any difficulties reasoning through or solving everyday problems (for example what would you do if you locked yourself out of the house or if you forgot the pin number on your cash dispensing card)?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q7: Do you feel you have any difficulties following a conversation when you are talking to a small group?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q8: Do you sometimes have difficulty putting your thoughts into words?

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q9: Do you feel you have any difficulty with *ability to concentrate?*

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q9b: If yes, how much does this impact on your life?

0----------1----------2----------3----------4----------5

Not at all Very Much So

Q10: Do you feel you have any difficulty with *your memory?*

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q10b: If yes, how much does this impact on your life?

0----------1----------2----------3----------4----------5

Not at all Very Much So

Q11: Do you feel you have any difficulty with *solving problems?*

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q11b: If yes, how much does this impact on your life*?*

0----------1----------2----------3----------4----------5

Not at all Very Much So

Q12: Do you feel you have any difficulty with *planning and organizing your daily activities?*

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q12b: If yes, how much does this impact on your life*?*

0----------1----------2----------3----------4----------5

Not at all Very Much So

Q13: Do you feel you have any difficulty with *communicating with others?*

0----------1----------2----------3----------4----------5

No Difficulty Severe Difficulty

Q13b: If yes, how much does this impact on your life*?*

0----------1----------2----------3----------4----------5

Not at all Very Much So

Now read Question 14. Look back through your answers and think carefully before you write down your thoughts for this last question.

Q14: Can you identify any particular areas of cognitive change that you feel you need further assistance with?

1._____
_____
_____

2._____
_____
_____

3._____
_____
_____

Appendix I: Knowledge of Brain Injury Questionnaire

Knowledge of Brain Injury

Please read each statement and circle the answer that most applies to you.

Q1
I have a good understanding of what an Acquired Brain Injury is.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q2
I have a good understanding of Fatigue Management.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q3
I have a good understanding of the working of the Brain.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q4
I have a good understanding of strategies that can be used to help cope with memory problems.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q5
I have a good understanding of the impact stress has on my ABI.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q6
I have a good understanding of the importance of working with no distractions.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q7
I have a good knowledge of the cause of an ABI.

Strongly Agree Agree Neither Disagree Strongly Disagree

Q8
I have a good knowledge of the possible impact of an ABI.

Strongly Agree Agree Neither Disagree Strongly Disagree

Appendix J: Ethics Committee Approval

NATIONAL UNIVERSITY OF IRELAND, MAYNOOTH
MAYNOOTH, CO. KILDARE, IRELAND

Dr Carol Barrett
Secretary to NUI Maynooth Ethics Committee

NUI MAYNOOTH

22 March 2013

Carol Rogan
Department of Psychology
NUI Maynooth

RE: Application for Ethical Approval for a project entitled:
"An examination of the effectiveness of a Cognitive Group intervention for people with Acquired Brain Injury"

Dear Carol,

The Ethics Committee evaluated the above project and we would like to inform you that ethical approval has been granted.

Kind Regards,

Dr Carol Barrett
Secretary, NUI Maynooth Ethics Committee

cc. Richard Roche, Department of Psychology, NUI Maynooth

Acquired Brain Injury Ireland Resource Centre
O' Meara House
Ballinacurra Road
Limerick
061-307-073

Ms Carol Rogan
Training Manager
Acquired Brain Injury Ireland
43 Northumberland Avenue
Dun Laoghaire
Co. Dublin

31st January 2013

Dear Carol

Re: Your proposed study "An evaluation of the Effectiveness of a Cognitive Group Intervention on People With Acquired Brain Injury

Thank you for your revised submission to the Acquired Brain Injury Ireland Ethics Committee (18th January 2013).

The committee has reviewed your application in detail and I am pleased to inform you that you have full ethical approval to conduct your study as outlined in your revised submission.

Yours sincerely

Dr. Donal Fortune

On behalf of the Acquired Brain Injury Ireland Ethics Committee.

Appendix K: Participant Advert and Information Sheet

Research Project Information Sheet-Participants

Project Title

A Cognitive Group Intervention for People with ABI

Background

Acquired Brain Injury (ABI) is associated with a range of physical, cognitive, emotional and behavioural changes (e.g. headaches, memory loss, depression and aggression). Neuropsychological rehabilitation is an intervention that can be used to address these difficulties. Neuropsychological rehabilitation is concerned with enabling people with cognitive (eg. memory, attention, executive functioning), emotional or behavioural deficits to achieve their maximum potential in the domains of psychological, social, leisure, vocational or everyday functioning.

Acquired Brain Injury Ireland currently run a 12-week Cognitive Group Programme. Topics included on the ABI Ireland programme are Knowledge of Brain Injury, Functions of the Brain, Fatigue Management, Stress, Anxiety & Relaxation, Attention, Memory and Executive Functioning. Homework exercises are given to participants each week and participants are given a tool-box of strategies which they can implement in their everyday lives. The aim of this current study is to examine the effectiveness of the 12-week programme in relation to cognition, distress, satisfaction with life, community integration and knowledge of brain injury. It is anticipated that taking part in the programme will result in positive benefits for participants in these areas.

What's Involved For Participants

Participants in the research project will be required to complete some questionnaires (approximately 1 hour) and some brief cognitive tasks (approximately 1 hour). These will be completed on joining the research project, 12 weeks later and again 6 months later. The questionnaires will explore issues around community integration, satisfaction with life, distress and knowledge of brain injury, as well as including a cognitive self-evaluation questionnaire. The questionnaires and tests will be completed in ABI Ireland premises or in a location convenient to you eg. your home.

Confidentiality

Responses provided on the questionnaires and results of cognitive tasks will be kept strictly confidential. A reference number will be assigned to each participant so that they remain anonymous in the report of findings. Participant data will be stored on a computer in the Psychology Department of Maynooth University and the computer is password protected for security. Hard copies of questionnaires and cognitive tests will be stored in a locked filing cabinet in the Psychology Department of Maynooth University. Participant data will only be used for the purposes of this research project and will only be shared with supervisors of the project (Dr. Brian Waldron, Senior Clinical Psychologist, ABI Ireland and Dr. Richard Roche, Psychology lecturer, Maynooth University). Participant data will be kept until the end of the research project (December 2018) and will then be stored on individual client files, held by the clinical team in ABI Ireland.

Benefits of This Research Project

There is currently a lack of research investigating the effects of such group-based ABI rehabilitation programmes. It is hoped that this current study will add to the limited research available in this area and

provide supporting evidence for the effectiveness of the current Cognitive Group programme run by ABI Ireland. It is also hoped that by demonstrating the positive benefits of such programmes, more of these programmes can be established in Ireland, which will directly benefit those with ABI and their families.

Contact Details

If any issues arise for you during or after taking part in the research project, you should discuss these with the member of ABI Ireland staff facilitating the group or contact Carol Rogan, Maynooth University, Mob: 087 9059634; Email:carol.rogan.2013@maynooth.ie) who will put you in touch with a member of ABI Ireland staff as appropriate.

Advertisement for Research Participants

Background

I am currently conducting a research project involving clients of Acquired Brain Injury Ireland. I am currently completing a PhD in Psychology in Maynooth University and I am interested in the area of neuropsychological rehabilitation after brain injury. Additional information can be found in the attached information sheet.

The title of the project is:

An evaluation of the Effectiveness of a Cognitive Group Intervention on People With Acquired Brain Injury.

Timeline

The plan is to recruit participants between March 2015-December 2017. Participants will be those who have signed up to attend an ABI Ireland Cognitive Group Programme or who are on a waiting list to attend a programme. The report of findings will be completed by December 2018 and participants will have access to the final report on request.

What's Involved?

It is proposed to include 70 participants from Ireland in this research project. The project will involve completing questionnaires (approximately 1 hour) and some brief cognitive tasks (approximately 1 hour). These will be completed upon signing up to the research project, 12 weeks later and again 6 months later. The questionnaires will explore issues around community integration, satisfaction with life, distress and knowledge of brain injury, as well as including a cognitive self-evaluation questionnaire. The questionnaires will be completed in ABI Ireland premises or in a location convenient to you eg. your home.

Confidentiality

Responses provided on the questionnaires and results of cognitive tasks will be kept completely confidential. A reference number will be assigned to each participant so that they remain anonymous in the report of findings.

Ethics

This research project has been approved by the Acquired Brain Injury Ireland Ethics Committee and the NUI Maynooth Ethics Committee.

If You Would Like To Participate

If you would like to participate in this project, please contact me-see contact details below.

Further Information

If you want to find out more about this research project or wish to discuss it with me, my contact details are as follows:

Carol Rogan, Department of Psychology, Maynooth University, John Hume Building, Maynooth, Co. Kildare. Mob: 087 9059634, Email: carol.rogan.2013@mumail.ie

Thank you for taking the time to read this information sheet.

Regards

Carol Rogan B.A. (Hons) Psych.

Appendix L: Consent Form

ACQUIRED BRAIN INJURY IRELAND RESEARCH CONSENT FORM

Title of Project: An evaluation of the Effectiveness of a Cognitive Group Intervention on People With Acquired Brain Injury

Name of Researcher: Carol Rogan

Please initial box

1. I confirm that I have read and understand the information sheet dated January 2015 for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time (up until the work is published), without giving any reason, without my treatment or legal rights being affected. ☐

3. I understand that sections of any of my ABI Ireland client notes may be looked at by responsible individuals from Acquired Brain Injury Ireland or from regulatory authorities where it is relevant to my taking part in research. I give permission for these individuals to have access to my records. ☐

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

Note 1: It is the client's responsibility to continue as normal, any medications they are taking and to attend any medical appointments or other services they were previously attending.

Note 2: This research will not form any kind of medical diagnosis or treatment

Note 3: You may access your data at your discretion

_____	_____	_____	
Name of Client	Date	Signature	
_____	_____	_____	
Name of Person taking consent	Date	Signature	
_____	_____	_____	
Researcher	Date	Signature	

Researcher Contact Details

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If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the National University of Ireland Maynooth Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.