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# Comparison of decision-making styles in individuals with acquired brain injury from different socio-economic strata.

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# Declaration

I hereby declare that this research report is my own independent work and has not been presented for any other degree at any other academic institution, or published in any form.

It is submitted in partial fulfilment of the requirements for the degree of Masters of Arts in Psychology by Coursework and Research Report at the University of the Witwatersrand, Johannesburg.

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# Introduction

Decision-making is, as far as it is known, peculiar to human beings. Not all decisions carry the same weight or are made in the same way. For most of the time, everyday decisions are neither correct nor incorrect, but are contextually appropriate depending upon the individual, the situation and the individual's goals at that point in time and are typically surrounded by ambiguity (Goldberg, 2009). Damasio's somatic marker hypothesis (SMH) exemplifies how somatic feedback can contribute to successful decision-making in ambiguous and complex situations (Damasio, Tranel, & Damasio, 1991; Dunn, Dalgleish, & Lawrence, 2006). For the purposes of the current study, three types of decision-making were selected. Firstly, actor centred decision-making is based on 'what is right for me' as an individual. Secondly, emotion-based decision-making (or 'gut feel') is frequently used when an individual swiftly makes daily decisions that are rooted in somatic feedback. Third and last, veridical decision-making is all about the 'right' answer – for example, the sum of three plus two is always five, and any other answer is wrong. In order to make appropriate and useful decisions, an individual needs intact frontal lobe structures.

The frontal lobes are physiological structures that are generally considered to be the site of executive function, a neuropsychological construct. An important part of executive functioning is the ability to make appropriate decisions in order to perform and succeed in goal directed behaviour; therefore it follows that individuals who have sustained damage to the frontal lobes could have impairments in decision-making. The three decision-making approaches mentioned above, namely actor-centred, veridical and emotion-based decision-making, can be measured using specific neuropsychological tests. Actor-centred decision-making can be assessed by the Tinker Toy Test (TTT) which requires the ability to formulate a goal as well as the ability to subsequently plan, initiate and perform a complex activity in order to reach that goal. Emotion-based decision-making has for many years been assessed using the Iowa Gambling Task (IGT) which is based upon the SMH (for example, see Bolla, Eldreth, Matochik, & Cadet, 2004; Bowman & Turnbull, 2004; Stocco & Fum, 2008; Turnbull, Berry, & Bowman, 2003). Cognitive-veridical decision-making can be assessed with the Wisconsin Card Sorting Test (WCST; Alvarez & Emory, 2006; Goldberg, 2009; Kolb & Whishaw, 2003; Nyhus & Barceló, 2009) which requires the individual to cognitively shift set to adapt to a change in circumstances and provide a response that is either correct or incorrect. All of the aforementioned instruments are used to assess executive function and therefore can also be used to assess decision-making. It follows that results of these tests can also give an indication of the extent of recovery in individuals who have sustained an acquired brain injury (ABI).

Acquired brain injury is the impairment of normal brain function, including cognitive impairment as a result of damage to the brain. This can be the outcome of a medical problem or trauma (traumatic brain injury or TBI; Toronto ABI Network, 2011). Whether the insult to the brain is more focal (from a medical problem) or more widespread (typically from a traumatic injury; Kolb, 2010), the outcomes and sequelae especially with regard to frontal lobe injury are very similar: lack of impulse control, loss of motivation, poor planning and decision-making, memory disturbances and personality changes (Prigatano & Fordyce, 1986). In summary, damage to the frontal lobes as a consequence of ABI leads to executive dysfunction, which in turn leads to poor decision-making.

Recovery from ABI is dependent on a variety of factors, such as site and severity of the injury, the individual's premorbid intelligence level, and the individual's socioeconomic status (SES). Markers of SES include the quality of medical care received at the time of injury, as well as quality of and level of education. This is the scope of the *cognitive reserve hypothesis* (CRH) which posits that a larger brain in an individual with a higher IQ and better education will be more resilient to injury or illness (Basso & Bornstein, 2000; Kesler, Adams, Blasey, & Bigler, 2003; Starr & Lonie, 2008). The CRH states that brain networks in constant and habitual use by a healthy person when performing at maximum capacity are less susceptible to disruption in the event of illness or injury. If these networks are widely distributed throughout the brain, there is a greater chance of 'buffering' in the event of brain damage (Stern, 2002). That is, a person with greater brain reserve or threshold, or with higher cognitive reserve could manifest a lower level of pathology after ABI compared to a person with lower physical or cognitive reserve (Stern, 2002). The CRH also holds that the number of distributed neural networks in the brain can be enhanced by higher intellect and more years of education, therefore individuals from a lower SES who have received less education and a poorer quality of education and medical care would not have the advantageous buffering effect of SES on brain injury. For example, Kesler and colleagues (2003) investigated the effect of injury on brain reserve capacity in participants with TBI using magnetic resonance imaging (MRI) analyses. The study found that level of education predicted the category of post-injury IQ (≥ 90 or <90), but premorbid standardised testing scores were not predictive of cognitive outcome. It was also found that participants with lower post-injury IQ scores had significantly lower total intracranial volume irrespective of severity of injury and manifested a significantly greater change in IQ from pre- to post-injury. It was concluded that results suggest that larger premorbid brain volume and higher education level may decrease vulnerability to brain injury (Kesler, et al., 2003).

SES is in itself an area of interest pertaining to recovery from ABI. Markers of SES include, but are not limited to, race or ethnicity, level of education, quality of education, and quality of and accessibility to medical care. For example, studies conducted in the United States suggest that factors such as minority status (Arango-Lasprilla, Rosenthal, Deluca, et al., 2007; Gary, Arango-Lasprilla, & Stevens, 2010) and ethnicity (Sherer, Nick, Sander, et al., 2003) can affect recovery from ABI. Sherer and colleagues (2003) found that African-Americans compared to Whites post-injury were twice as likely to be unproductive after an ABI (Sherer, et al., 2003). In a review of care received at the time of injury, Gary and colleagues (2010) concluded that minorities in the United States had more problems in returning to work and becoming productive when compared to Whites. Areas of post-injury function that were reviewed included community integration , marital status, life satisfaction and neuropsychological outcomes (Gary, et al., 2010) Similarly, a study by Sander and colleagues (2009) on re-integration into the community after traumatic brain injury (TBI) revealed that those from minority groups in the US (i.e. African Americans and Hispanics) have less favourable outcomes when compared to Whites after TBI (Sander, et al., 2009).

In South Africa there has historically been a discrepancy between those from different cultures in terms of income, work availability, education, medical services and basic living standards (Baker, 2010; Coovadia, Jewkes, Barron, Sanders, & McIntyre, 2009; Fry, Greenop, Turnbull, & Bowman, 2009). For example, South African studies found that the disparity of education between former Private/Model C and Department of Education and Training (DET) schools (a marker of SES) can have an impact upon neuropsychological test results (Cavé, 2008; Shuttleworth-Edwards, 2010). In another study Fry and colleagues (2009) concluded that the outcomes of the Iowa Gambling Task (IGT) between those with different levels of education may have been a result of socioeconomic differences in South Africa.

For the current study, it was hypothesised that there would be differences in decision-making between individuals with ABI from a high SES background versus those with ABI from a low SES background, as those from a low SES would typically have less education, poorer quality of education and poor medical care. All of these factors have been shown to buffer cognitive function in the event of injury (Kesler, et al., 2003). Thus it was hypothesised that because SES is a marker for poorer education and quality of medical care, differences in decision-making will be exacerbated between individuals from different socio-economic levels after ABI.

The primary aim of this study was to examine decision-making after ABI, using a sample of individuals with brain injury from both higher and lower socioeconomic strata. The two groups were evaluated on veridical, actor-centred and emotion-based decision-making using instruments that not only focused on different styles of decision-making but could differentiate between brain-injured and neurologically intact individuals. Actor-centred decision-making was assessed using the Tinker Toy Test (Goldberg, 2009; Lezak, 1995). Emotion-based decision-making was evaluated using the computerised version of the Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara & Damasio, 1997; Bechara, Damasio, Damasio, & Lee, 1999; Damasio, et al., 1991) and veridical decision-making with the Berg Card Sorting Task (BCST; PEBL Psychological Test Battery, 2009), a computerised version of the Wisconsin Card Sorting Task (WCST) developed in 1948 by Berg et al. (Greve, Ingram, & Bianchini, 1998; Heaton, Chelune, Talley, Kay, & Curtiss, 1993). The participants (*n* = 25) were purposively sampled from Headway Gauteng, an organisation for victims of ABI based in Johannesburg, South Africa.

A literature review follows in Chapter Two that explores decision-making in more depth, describing the three types of decision-making (actor-centred, veridical and emotion-based decision-making) and the different instruments used to assess each. The literature review also expands on ABI, the effect of ABI on executive functioning, and predictors of recovery from ABI. The Cognitive Reserve Hypothesis is outlined and environmental factors that can have an influence on recovery such as socioeconomic status (SES), race and ethnicity, education and medical care at time of injury are explored. Chapter Three outlines the method used to conduct the current study and describes the participants, the research design, the instruments used to measure the abovementioned types of decision-making, the study procedure, variables and threats to validity. The data analyses used are outlined and ethical considerations are presented. Chapter Four describes the results of the analyses of the variables of interest: SES, race, level and quality of education and quality of medical care. The concluding Chapter Five is a discussion of the results with regard to the abovementioned variables of interest. Limitations of the current study are discussed, as are future research directions.

# Literature Review

*I didn't imagine that a brain tumour would cost such a lot. He has lost most of his decision-making abilities and becomes bad-tempered easily.* (Man, 2002, p. 1030)

## Decision-Making

Making decisions is an intrinsic part of the human condition. Indeed, one of the functions that differentiates human beings from the rest of the animal kingdom is the awareness for at least some of the time that we are in fact making a decision. The human animal constantly needs to be able to make appropriate decisions in order to adapt to a highly complex social world, as well as to the minutiae of everyday life. Decision-making by its very nature involves goal-setting, planning and execution as well as the continuous monitoring of behaviour over time. All of these activities are part of the human brain's executive functions (Garon & Moore, 2004; Goldberg, 2009). Therefore successful decision-making requires the ability to remember the outcomes of past events and to anticipate the consequences of future events (Garon & Moore, 2004).

Decision-making has been presented in the literature as having two aspects: controlled processing (deliberative, rational and analytic) and automatic processing (implicit, intuitive and emotional; Body, 2007). Three types of decision-making approaches have been identified: *actor-centred, veridical*, and *emotion-based* decision-making (Goldberg, 2009; Turnbull, et al., 2003). Whereas veridical decision-making is related to controlled processing, and emotion-based decision making to automatic processing, actor-centred decision making can arguably be a combination of the two. Goldberg (2009) distinguishes between actor-centred decision-making (the right response for the individual in the current context) and veridical decision-making (the right/correct versus the wrong/incorrect response). Emotion-based decision-making is conceptually rooted in physiological markers or somatic signals (Damasio, et al., 1991).

### Neurological and anatomical bases of decision-making.

Alvarez and Emory (2006) describe three principal frontal subcortical circuits that are involved in cognitive, emotional, and motivational processes, all of which are necessary for successful and appropriate decision-making. Firstly, the dorsolateral prefrontal cortex (DLPFC) projects primarily to the dorsolateral head of the caudate nucleus and is linked to the ability to maintain and shift set, plan, inhibit responses, as well as working memory, organizational skills, reasoning, problem-solving, and abstract thinking. Veridical decision-making and cognitive set-shifting are part of the executive functions of the DLPFC (Goldberg, 2009). Secondly, the ventromedial circuit (which has a role in motivation) begins in the anterior cingulate and projects to the nucleus accumbens. Finally, the orbitofrontal cortex (OFC) projects to the ventromedial caudate nucleus and is associated with expression of emotion as well as socially appropriate behaviour. The orbitofrontal cortex is connected to subcortical structures that play an important role in monitoring one's internal states which in turn play an important part in emotion-based decision-making (Alvarez & Emory, 2006).

In order for integrated, seamless decision-making to be possible, the prefrontal cortex (PFC) and the amygdala function in a complementary fashion with the mesolimbic pathways from the amygdala, and mesocortical pathways from the PFC (Goldberg, 2009). The amygdala plays a role in emotion-based decision-making where the context is of rapid, simple decisions in cue- and survival-based situations. In contrast, veridical decision-making occurs in the context of decisions that are more cognitive and considered, are slower and which are made by the PFC. If a particular context is significant to the individual (an actor-centred context) the PFC and amygdala act together to send a signal to the ventral tegmental area (VTA) which stimulates various neural structures (such as the dopaminergic hippocampal pathways) that in turn facilitate the formation of long-term memories used as the knowledge-base in the different types and contexts of decision-making (Goldberg, 2009). The three types of decision-making mentioned above (actor-centred, veridical, and emotion-based) are discussed in more detail below.

#### "What's right for me?": Actor-centred decision-making.

Goldberg (2009) maintains that the majority of everyday decisions are neither correct nor incorrect, but are contextually appropriate depending upon the individual, the individual's situation and his or her goals at that point in time. These everyday decisions are surrounded by ambiguity – there is no 'right' or 'wrong' answer. A typical actor-centred decision would be 'Where shall I go on holiday, Durban or Cape Town?' The decision made by the individual depends on his or her personal preferences. Actor-centred decision-making is idiosyncratic as well as contextual, that is a person's preferences may be stable (idiosyncratic) or may change according to the context (Goldberg, Harner, Lovell, Podell, & Riggio, 1994).

#### Finding the truth: Veridical decision-making.

Veridical decision-making concerns 'right' or 'wrong' answers to situations that are inherently deterministic (Goldberg, 2009). To give some concrete examples: what is the sum of three and two? What is a particular person's telephone number? What is the speed limit along a particular road? There is only one correct answer to these questions with no place for ambiguity. However, should a particular person change their telephone number, or the speed limit along a certain road be changed, the individual would need to cognitively shift set. Cognitive flexibility is an important component of the goal-directed action that leads to veridical decision-making. Cognitive shifts can be elicited by implicit 'rule changes' in a social and practical context (Smillie, Cooper, Tharp, & Pelling, 2009).

#### 'Gut feel': Emotion-based decision-making.

Like actor-centred decision-making, emotion-based decision-making is primarily used in situations that have an element of ambiguity. Many of our daily choices are not made using conscious deliberation, but simply because the chosen response 'feels right' (Dunn, et al., 2006;

Turnbull, et al., 2003). Damasio's somatic marker hypothesis (SMH) describes how somatic feedback can contribute to successful decision-making. Somatic feedback is an unconscious physiological reaction that is activated in situations of ambiguity, where outcomes of choices are highly unpredictable (Bechara, 2004) and it has been suggested that this system is what underlies the popular notion of "gut feelings" (Kovaichik & Aliman, 2006, p. 715). The SMH posits that somatic markers provide the individual with a physiological reaction, or "gut feeling on the merits of a given response" (Damasio, et al., 1991, p. 222). It is this physiological reaction that assists with the decision-making process especially in ambiguous and complex situations (Dunn, et al., 2006).

The basis of emotion-based decision-making is learning. The somatic marker initially evokes a physiological sensation based on the possible outcomes of a particular response. The neural systems that modify cortical processing are subsequently affected, resulting in a somatic state that inhibits responses leading to unfavourable outcomes (Damasio, et al., 1991). Emotion based systems therefore appear to serve as the intermediary between low-level (physiological and sub-cortical) emotional experience, and high-level (cortical) cognition. This forms the basis for intuition or 'gut feeling' regarding a possible outcome to a problem (Turnbull, Worsey, & Bowman, 2007).

**Decision-making and executive functioning.**

The ability to make decisions appears to be associated with functions of the frontal lobes and it follows that this ability is highly developed in humans (Goldberg, 2009). All three of the decision-making approaches described above also require intact executive functioning. In order to decide upon appropriate goal-oriented purposeful behaviour necessary to make a decision, a sequence of events must take place (Goldberg, 2009). The individual must first initiate the goal-seeking behaviour, then identify the objective of the goal followed by the formulation of an appropriate plan of action. Next the means by which the plan can be best accomplished must be selected, and the stages of the plan then need to be followed in the correct order. Finally, upon achieving the goal, the individual will need to compare the outcome of his or her behaviour to the desired goal – and decide whether the goal has or has not been achieved (Goldberg, 2009).

Functions such as goal setting, planning, and follow-through all require intact frontal lobes. The right anterior frontopolar regions are associated with exploratory behaviours (Daw, O'Doherty, Dayan, Seymour, & Dolan, 2006) and are important for decision-making in novel and possibly ambiguous situations, such as those in which emotion-based decision making will be employed. On the other hand, perceptual decision-making involves targets that are readily recognisable as belonging to known categories and is guided by the left dorsolateral prefrontal cortical (DLPFC) regions (Heekeren, Marrett, Bandettini, & Ungerleider, 2004). This area therefore has a role in less conscious and more 'automatic' decision-making in a familiar context.

In actor-centred decisions, an individual needs to be able to resolve the ambiguity that is inherent in a complex social world. In order to "disambiguate the situation" (Goldberg, 2009, p. 99), a person is required to take a top-down approach and to break down the original, general question into smaller, more specific sub-questions. This implies planning and goal setting, which is dependent upon the frontal lobes (Goldberg, 2009).

In everyday life, coping with deterministic or veridical situations is often achieved by using pre-existing cognitive structures or frameworks that assist the individual in successful decision-making. At times, however, the correct answer may change (such as in the example of the speed limit above) and the individual will need to cognitively shift set.

Emotional decision-making has its foundation in a subcortical response to somatic markers, resulting in two events. The initial effect of the somatic marker is to provide a physiological sensation that forces an individual to attend to positive or negative aspects of possible response options. The second effect is more subtle: the state of the neural systems that trigger appetitive or aversive behaviours is modified (Damasio, et al., 1991). For example, a particular response can evoke a future scenario (regardless of any immediate reward) that could be potentially threatening to the individual and is marked by a negative somatic state such as an uncomfortable sensation or 'gut feeling'. As an individual 'experiences' an enactment of punishment he or she will avoid that particular response. This sequence of responses relies on an intact network of brain structures: the ventromedial frontal cortices, subcortical structures (notably the amygdala) and somatosensory cortices and projection systems (Damasio, et al., 1991).

The decision-making approaches described above are part of intact executive functioning. Executive functioning can be assessed by a number of neuropsychological tests.

**Neuropsychological tests that assess decision-making.**

As discussed above, decision-making is a component of executive functioning, therefore a number of neuropsychological tests that tap into and assess executive function will also be appropriate for the assessment of decision-making. For example, tests that have been used in studies that evaluate executive function are the Wisconsin Card Sorting Task (WCST; Alvarez & Emory, 2006; Nyhus & Barceló, 2009), the Phonemic Verbal Fluency Test, the Stroop Colour Word Interference Test (Alvarez & Emory, 2006), the Tower of Hanoi computerized version (Bechara & Damasio, 2002), the Tinker Toy Test (TTT; Lezak, Howieson, & Loring, 2004), the Cognitive Bias Test (Goldberg, 2009; Goldberg, et al., 1994), and the Iowa Gambling Task (IGT; Bechara, 2004; Bechara, Damasio, Tranel , & Damasio, 2005). With regard to the areas of decision-making described above, it is argued that the TTT is a measure of actor-centred decision-making (in which the participant is given minimal guidance), the WCST is a useful measure of veridical decision-making (the participant is informed whether their response is right or wrong), and the IGT an appropriate measure of emotion-based decision-making.

***The Tinker Toy Test (TTT): Actor-centred decision-making.***

In everyday life, actor-centred decision-making more often than not takes place under ambiguous circumstances. This ambiguity has been operationalised by Lezak's (2004) Tinker

Toy Test (TTT) which requires the participant to make his or her own choices with little or no input from the test administrator. The TTT requires the participant to build a construction of their own choice using pieces of the Tinker Toy Set®. This test is a measure of goal-setting ability, planning and decision-making and can elicit evidence of impaired orbitofrontal functioning in individuals with brain injury (Varney & Stewart, 2004). The instrument was initially developed for young people with brain injuries and has since been used in other neurological areas, such as to evaluate the outcomes of Alzheimer's Disease (Koss, Patterson, Mack, Smyth, & Whitehouse, 1998) and stroke (Ownsworth & Shum, 2008). Certain executive functions contribute to the composite score of the TTT, such as the ability to formulate a goal, plan towards it, and thereafter initiate and follow through with a complex activity to achieve it (Lezak, et al., 2004)

Concurrent validity of the TTT was demonstrated by Varney and Stewart (2004) who compared the performance of two groups of participants on the TTT and the Design Fluency (DF) test, a test of non-verbal association fluency that can elicit evidence of diffuse frontal lobe damage. One group of participants had sustained a traumatic brain injury and the other was a neurologically normal control group. Results showed that the severity of impairment in the performance of brain-injured participants on the DF was strongly correlated with their performance on the TTT (Varney & Stewart, 2004).

Bayless and colleagues (1989) found that the TTT demonstrated predictive validity with regard to returning to work in individuals who had sustained a closed-head injury. They reported that participants who were unable to return to work had achieved scores on the TTT that were considerably lower compared to participants who had returned to work. More than half of the disabled patients performed below the level of the worst normal control participant on the TTT. Nearly all of those with head injuries who had returned to work achieved scores within the range of uninjured normal controls (Bayless, et al., 1989). Koss and colleagues (1998) found evidence for the reliability and utility of the test when they evaluated the TTT in subjects with dementia. Ownsworth and Shum (2008) found there were no significant differences on the TTT between individuals with or without hemiplegia or aphasia.

It is argued that actor-centred decision-making requires the formation of a plan, and the motivation and flexibility to follow through and reach the planned goal. As the TTT requires the participant to build a construction with minimal input from the examiner, it can be used as a test of actor-centred decision making. On the basis of this, it was decided to include the TTT in the current study.

***The Wisconsin Card Sorting Task (WCST): Veridical decision-making.***

Veridical decision-making can be assessed using the Wisconsin Card Sorting Test (WCST) which was developed in 1948 by Berg et al. (Greve, et al., 1998; Heaton, et al., 1993). The WCST appears to tap into neuropsychological processes that involve cognitive flexibility, problem-solving, and the ability to follow through on a decision (Alvarez & Emory, 2006), all of which are also required for effective and appropriate decision-making. The WCST requires individuals to correctly sort cards according to a rule that is only known to the examiner and which periodically changes. Participants needs to logically deduce which rule is valid, and must be able to cognitively shift to as well as maintain the new rule. There has been much research into the specificity of the WCST and the brain regions that are activated in performing the task.

Initially the WCST was thought to be able to isolate and identify deficiencies in frontal lobe function alone (Milner, 1963; cited in Nyhus & Barceló, 2009). However, with the advent of neuroimaging studies and neural network modelling, it has become apparent that the WCST cannot differentiate between functions of the frontal lobe and those of other structures (Alvarez & Emory, 2006; Nyhus & Barceló, 2009). Therefore the WCST not only taps into the cortical functions that are required for veridical decision-making, but also into sub-cortical functions. Cortical structures other than the frontal lobes that are activated by the WCST include the inferior parietal lobes, temporo-parietal association cortex, primary and secondary association visual cortices, i.e. the occipito-temporal, temporal pole, and occipital cortices (Nyhus & Barceló, 2009). It has also been suggested that subcortical structures such as the mid-thalamus, basal ganglia, parahippocampal gyri, and the hippocampus are involved in the execution of the WCST (Alvarez & Emory, 2006).

A recent review of clinical and neuroimaging studies of the WCST was conducted by Nyhus and Barceló (2009). They maintained that in her 1951 research, Milner found a greater number of total errors were made by patients with posterior lesions when compared to those with frontal lesions. Other research has found that both damage to non-frontal regions as well as diffuse damage to frontal and non-frontal regions affect WCST performance. It was also reported that damage to temporal, subcortical, hippocampal, and cerebellar regions result in similar impairments on WCST performance as those resulting from frontal lobe lesions (Nyhus & Barceló, 2009). In the same review, an analysis of neuroimaging studies of WCST performance in normal controls indicated there was a significant increase in metabolic or neural activity within the prefrontal cortical regions. In the majority of the studies reviewed, the increase in activation was found in the DLPFC, whereas other studies have also revealed activation in ventrolateral prefrontal cortex (VPFC; Nyhus & Barceló, 2009).

In a similar meta-analytic review, Alvarez and Emory (2006) examined three tests of executive functioning: the WCST, the Phonemic Verbal Fluency Test and the Stroop Colour Word Interference Test. The authors reported that although the lesion studies that were reviewed lent support to the sensitivity of the WCST in terms of frontal lobe versus non-frontal lobe lesions, there was no support for the specificity of the test to frontal lobe lesions. With regard to neuroimaging studies of administration of the WCST, the authors stated that all were consistent with lesion studies in reporting no significant differences between frontal groups and non-frontal, diffuse, or basal ganglia comparison groups (Alvarez & Emory, 2006). In both of the above reviews, both sets of authors concurred that many studies indicate not only that the WCST is a marker of prefrontal function, but that performance on the WCST activates a distributed neural network involving both frontal and non-frontal brain regions (Alvarez & Emory, 2006; Nyhus & Barceló, 2009).

The WCST has some limitations such as a significant gender effect in older adults (aged over 60 years), in which women significantly outperformed men on a number of variables (Boone, Ghaffarian, Lesser, Hill-Gutierrez, & Berman, 1993). This would not have had an effect on the current study, however, as all of the participants were younger than 60 years of age. The literature suggests that performance on the WCST is impaired in persons with damage to frontal as well as non-frontal regions. As discussed above, although the frontal regions are assumed to be the site of executive function, successful decision-making also relies on subcortical structures and pathways. The use of the WCST as a test of decision-making in the current study is therefore argued to be appropriate.

***The Iowa Gambling Task (IGT: Emotion-based decision-making.***

The most widely researched test of emotion-based decision-making is the Iowa Gambling Task (IGT) which was initially developed as a 'real-life' operationalisation of a gambling game to confirm Damasio's somatic marker hypothesis (SMH; Bechara, et al., 1999; Bowman & Turnbull, 2004; Stocco & Fum, 2008; Turnbull, et al., 2003; Turnbull, Evans, Bunce, Carzolio, & O'Connor, 2005). It has been suggested that the IGT is sensitive to damage in the ventromedial prefrontal cortex (VMPFC; Bowman, Evans, & Turnbull, 2005). Each trial of the IGT requires the participant to select one of four decks in any order. He or she wins money with each card turn, but will sometimes lose money on certain selections. Continuous selection of certain decks can lead to overall financial loss (the 'bad' decks), whereas playing other decks (the 'good' decks) will lead to small but consistent gains. In general, neurologically healthy individuals will gradually shift towards a preference for the 'good' versus the 'bad' decks. It is hypothesised that poor judgement and decision-making abilities appear to result from an inability to use somatic markers or emotion-based knowledge about the possible outcome of decisions (Bowman & Turnbull, 2004). The claim that the IGT represents a test of emotion-based learning is based on two premises: (1) that participants show reliable modifications in skin conductance, and (2) this test is frequently failed by patients with lesions in the VMPFC (Bowman & Turnbull, 2004).

Despite being used extensively as a test of emotion-based decision-making (for example, see Balodis, MacDonald, & Olmstead, 2006; Bolla, et al., 2004; Brand, Recknor, Grabenhorst, & Bechara, 2007; Denburg, Tranel, & Bechara, 2005; Overman, Frassrand, Ansel, et al., 2004; Stocco & Fum, 2008), the IGT is not without its critics. Dunn, Dalgliesh and Lawrence (2006) have argued that the SMH is simplistic and does not take into account the ambiguity surrounding the psychophysiological data, nor the lack of causal evidence linking peripheral feedback to performance on the Iowa Gambling Task (IGT) upon which evidence for the SMH is largely based.

Stocco, Fum and Napoli (2009) maintained that the unstructured nature of the IGT poses certain limitations in characterising underlying cognitive processes. The IGT makes use of two kinds of cognitive operations: (1) learning about the task structure from the cards' feedback, and (2) using this information to decide upon which deck to choose. Earlier research studies attributed abnormal choice behaviour to the decision component of the task, but it was posited that low scores could result from difficulties in learning, or even a combination of the two (Stocco, et al., 2009). The study by Stocco and colleagues (2009) found a correlation between working memory impairment and low performance on the IGT in individuals with substance dependence. With regard to sensitivity of the IGT to VMPFC damage, there is a confounding effect which is demonstrated by the "prominent deck B phenomenon" (Chiu, Lin, Huang, et al., 2008, n.p.). It appears that immediate gain-loss frequency rather than expected value governs the choice behaviour of neurologically healthy individuals in uncertain or ambiguous conditions. A modification of the IGT, the Soochow Gambling Task, revealed that participants' selection patterns were mostly predicted based on gain-loss frequency (Chiu, et al., 2008).

In a critical evaluation of the IGT, Dunn and colleagues (2006) noted certain weaknesses concerning the interdependence of the SMH and the IGT. For example, there is a substantial minority of neurologically healthy participants who make disadvantageous decisions. One study reported that 20% of neurologically-normal adults made more selections from the 'bad' than from the 'good' decks (Bechara & Damasio, 2002). It was further noted that performance deficits on the IGT do not show sensitivity to any specific neurological deficit, as the majority of both psychiatric and neurological patient groups appear to perform badly on the task. However, Dunn and colleagues (2006) also summarised the following strengths of the IGT: (1) disparities in performance on the IGT between those with brain damage and healthy controls have been extensively validated under laboratory conditions, (2) the IGT has been demonstrated to be robust in the face of parameter changes (for example, using real money rather than play money), (3) age and gender differences in performance have been demonstrated, (4) the behavioural form of the task has been shown to be sensitive to both neurological and psychiatric impairment, and (5) evidence is increasing that the IGT has reasonable predictive validity (Dunn, et al., 2006).

Other advantages of the IGT are that it has been tested on both neurologically normal and brain-injured populations, with the focus on gender, age, and level of education (for example, see Bolla, et al., 2004; Brand, et al., 2007; Caroselli, Hiscock, Scheibel, & Ingram, 2006; Denburg, et al., 2005; Evans, Kemish, & Turnbull, 2004; Fry, et al., 2009; Garon & Moore, 2004; Isella, Mapelli, Morielli, et al., 2008). The IGT has been shown to be sensitive to the level of education. Fry and colleagues (2009) found that individuals with more years of education (to tertiary level) performed less well than those with a basic level of education (up to secondary level). The IGT has been shown to be sensitive to neurological impairment (Evans, Bowman, & Turnbull, 2005; Fellows, 2007; Hanten, Scheibel, Li, et al., 2006; Smillie, et al., 2009) and years of education (Evans, et al., 2004; Fry, et al., 2009). It was therefore deemed appropriate to use the IGT to assess emotion-based decision-making in the current study.

Therefore, with regard to neuropsychological tests that assess decision-making, the TTT has been shown to be sensitive to goal setting, planning and initiation in an ambiguous situation, the WCST has demonstrated sensitivity to executive dysfunction specifically with shifting set and planning, and the IGT has demonstrated differences in performance between those who are neurologically healthy and those with brain injury. These tests therefore have validity when assessing actor-centred (the TTT), veridical (the WCST) and emotion-based decision-making (the IGT). Inasmuch as the decision-making approaches described above need intact executive functioning, intact executive functioning in turn, needs an intact brain. The brain can be damaged or become dysfunctional as a result of a variety of factors. One such factor is Acquired Brain Injury (ABI).

## Acquired Brain Injury (ABI)

Acquired brain injury (ABI) is defined as an insult to the brain that is not congenital, nor related to a developmental disability or a degenerative process. Damage to the brain is most commonly a result either of a trauma or of a medical problem, such as stroke, anoxia or central nervous system surgery (Headway UK, 2009).

Non-traumatic brain injuries are sustained as a result of stroke, haemorrhage, infection, hypoxic or anoxic brain injury, and medical accidents. A traumatic brain injury (TBI) is caused by a trauma to the head, for example as a consequence of a motor vehicle accident, a fall, or as a victim of violence. Strictly speaking, TBI is a subset of ABI (which is the position taken in the current study). The effects of both non-traumatic and traumatic brain injury can be wide ranging, and can depend on a number of factors such as the type, location and severity of injury (Headway UK, 2009). Examples of such factors are premorbid socioeconomic status (SES), markers for which include race or ethnicity, level and quality of education, and type of medical care received at the time of injury. Therefore, outcomes on tests of decision-making in people who have sustained ABI are not only influenced by intrapersonal factors, (such as the site and severity of the lesion), but also by environmental factors (such as socio-economic status), all of which have an effect on the individual's recovery.

The severity and location of the injury are the main predictors of future cognitive dysfunction and psychosocial consequences such as impulsivity, poor judgement, paranoia, slowed information processing and memory deficits. With regard to lesions of the frontal lobes in particular, certain characteristic behaviours emerge which include perseveration, difficulty in learning from mistakes and/or successes, and lack of insight (Goldberg, 2009; Prigatano & Fordyce, 1986). These consequences of ABI are all applicable to successful decision-making which requires learning (dependent upon memory for outcomes) planning, cognitive flexibility (set-shifting as opposed to perseveration), and appropriate judgement.

### Acquired Brain Injury and its effect on executive function and decision-making.

It has been reported that sequelae of ABI include disorders of attention, information processing, and short-term and working memory. These impairments can have an impact on intrapersonal insight, the perception of emotion and on interpersonal communication leading to difficulties in social interactions (Body, 2007). This lack of insight is associated with damage to the frontal lobes and is considered one of the most devastating neuropsychological impairments in ABI (Gan & Schuller, 2002).

One factor that can have an effect on recovery after an ABI is the severity of the injury, as exemplified in a study by Fork and colleagues (2005) that examined neuropsychological deficits after TBI. Outcomes at four weeks post-injury were compared to those at five to eight months post-injury in two groups of individuals: those with diffuse axonal injury (DAI - damage that occurs over a widespread area of the brain) and those who had merely sustained frontal contusions. It was reported that at four weeks post injury, individuals both with DAI and frontal contusions exhibited behavioural abnormalities and deficits in the Wechsler Similarities Subtest, the California Verbal Learning Test (CVLT) and in the WCST. The DAI patients were also impaired on the Wechsler Digit Span Backward Subtest and Stroop Interference Test. When reassessed some months later, only the DAI patients showed performance deficits in the CVLT and the WCST. The authors concluded that the deficits in patients with DAI could be interpreted in terms of an executive dysfunction that manifested in difficulties with organizing information during acquisition and retrieval (Fork, et al., 2005).

The consensus of current research into ABI is that it generally leads to executive dysfunction, especially when there is damage to the frontal lobes. In addition to the social, environmental and neuropsychiatric outcomes of ABI, executive dysfunction is the source of a great many research studies. As described above, executive function has many facets including goal setting, planning and decision-making. One of the components of executive dysfunction that currently generates a great deal of research is that of decision-making (for example, see Bechara, et al., 1999; Evans, et al., 2005; Goldberg, 2009; Hanten, et al., 2006; Smillie, et al., 2009; Turnbull, et al., 2005).

Damage to one or both frontal lobes can result in the disintegration of executive function. For example, damage to the orbital regions of the frontal lobe can result in disinhibition, impulsivity, and antisocial behaviour, a phenomenon known as *pseudopsychopathy* or orbitofrontal syndrome (Alvarez & Emory, 2006; Kolb & Whishaw, 2003). Individuals with orbitofrontal syndrome present with immature, adolescent behaviour and little evidence of tact or restraint (Goldberg, 2009; Kolb & Whishaw, 2003), all of which can have a negative impact on appropriate decision-making. Dorsolateral frontal syndrome or *pseudodepression* manifests after damage to the ventromedial circuit, which plays a role in motivation (Kolb & Whishaw, 2003). The individual exhibits apathy, decreased social interaction, psychomotor retardation, extreme inertia and an inability to initiate or terminate behaviours (Alvarez & Emory, 2006; Goldberg, 2009). This inertia of termination can result in perseveration: once engaged in a particular behaviour, an individual is equally unable to spontaneously change or terminate it (Goldberg, 2009). Flexibility of thinking becomes impaired together with the ability to shift set. The person will perseverate and continue to apply an outdated rule (Goldberg, 2009; Smillie, et al., 2009) and as a result make poor decisions.

In the injured brain the complementary roles of the PFC (slower, learned, conscious decisions) and the amygdala (rapid, simple, cue-based decisions) break down. It is these complementary functions that facilitate the formation of long-term memories which underlie the different types and contexts of decision-making. When cortical and subcortical levels of functioning become dissociated, the coordination of cognitive skills into a coherent goal setting or decision-making ability is impaired (Goldberg, 2009).

Many studies have shown that frontal lobe injury does not merely impair judgement of contexts but also decision-making within a context. It has been proposed that some tests of decision-making (such as the IGT) provide an index of decision-making accuracy and impulsivity, and when used as part of a larger battery can provide insights into the neuropsychological influences on decision-making (Hartman, 2008).

Priority based, adaptive, actor-centred decision-making in ambiguous contexts is central to human life and intact frontal lobes play an essential role in such decision-making. People with frontal lobe damage find it easier to make decisions that have been disambiguated and reduced to a correct or incorrect response (Bowman & Turnbull, 2009; Brand, et al., 2007; Goldberg, 2009; Smillie, et al., 2009). For example, Goldberg and colleagues (1994) tested differences in decision-making in an ambiguous context between healthy individuals and those with frontal lobe damage. Participants were shown a geometric design (the target) followed by two other designs (the choices). In the ambiguous condition participants were asked to choose the design they liked best. A significant difference was noted between the performance of healthy participants and those with frontal lobe damage. Participants were then asked to choose the design most similar to the target (the unambiguous condition). Once ambiguity had been removed from the decision-making context, the performance of both healthy and brain-damaged participants was similar (Goldberg, 2009).

As some decision-making contexts are more clear-cut than others, an individual needs an array of decision-making styles. One of the sequelae of an insult to the frontal lobes, whether through injury or illness, is diminished flexibility of thought and an inability to adapt to novel situations (Goldberg, 2009; Lezak, et al., 2004; Turnbull, et al., 2007). The mental rigidity that is exhibited after frontal lobe damage can manifest in perseveration, indicative of the failure of the frontal lobes to guide the behaviour of a different part of the brain (such as is required for veridical decision-making). This diminished capacity for flexible thinking can limit imaginative and creative thinking and lead to apathy, reduced volition, as well as problems with decision-making (Brand, et al., 2007; Goldberg, 2009; Lezak, et al., 2004). Impaired ability to discard one rule for another (i.e. to shift set) has been most noted in patients with damage to or disorders of the prefrontal cortex (Smillie, et al., 2009). Inability to plan and anticipate the consequences of one's actions is another consequence of damage to the frontal lobe, all of which impacts effective and efficient decision-making (Dunn, et al., 2006; Goldberg, 2009).

Turnbull and colleagues (2003) maintain that poor judgement and impaired emotion-based decision-making is a consequence of an inability to use somatic markers or "emotion-based knowledge about the possible outcome of decisions" (Turnbull, et al., 2003, p. 389). This was exemplified in a study by Bechara and colleagues (1999) who used the IGT, a simulated gambling task. In this study, participants with ventromedial frontal (VMF) lesions were instructed to maximise their profit (in play money) by choosing from the most advantageous of four decks of cards. Choices from any deck resulted in a reward, but some decks incurred greater penalties than others. Each of the four decks therefore becomes associated with states of reward and of punishment. Greater losses and poor decision-making were associated with participants who had damage to the VMF (Bechara, et al., 1999).

A substantial portion of research into brain injury is focused on recovery and a resumption of normal daily life. Indeed, a number of individuals with a mild brain injury are able to return to work although perhaps at a more subordinate level than before (Gary, et al., 2010; Hammond, Grattan, Sasser, et al., 2004; Ownsworth & Shum, 2008; Watt & Penn, 2000). This would imply that the person who has sustained a brain injury would be able to make the day to day decisions necessary to hold down a job and to conduct interpersonal relationships with colleagues. However those who do return to work are often unable to operate at their pre-morbid cognitive level (Bayless, et al., 1989). An individual who has sustained frontal lobe damage may generally appear to be unimpaired, to retain the ability to read and write, to perform simple computations, to express him or herself verbally, and to move normally. He or she may perform well on tests measuring these functions. However, because of damage to the frontal lobes, the person will have difficulty synthesising these functions into making decision, goal-directed planning and behaviour (Goldberg, 2009).

In summary, individuals who have sustained brain damage have a diminished capacity for flexible thought and a reduced ability to form a plan of action. Apathy is often manifested which can inhibit goal-directed behaviour. Individuals with ABI have difficulty in making decisions in ambiguous contexts, the very contexts in which day to day decisions are often made. The inability to anticipate the consequences of one's actions has by association a negative impact on efficient and appropriate decision-making. It would appear then, that individuals who have acquired brain injury, particularly to the frontal lobes, will exhibit executive dysfunction and as a result, impaired decision-making. One cannot state with certainty that ABI will lead to executive dysfunction, nor can one predict with certainty the extent of the dysfunction.

**Predictors of recovery from Acquired Brain Injury.**

Recovery after brain injury depends on a number of factors: the size and location of the lesion, the Glasgow Coma Scale score at time of injury (Teasdale & Jennett, 1974), the duration of coma and of post-traumatic amnesia (PTA), the individual's premorbid abilities and experiences, his or her socio-economic status and psychological makeup, all of which affect how the individual will respond to an insult to the brain. The individual's insight into their strengths and weaknesses as well as family, social and economic support or lack thereof after injury can also affect recovery (Lezak, et al., 2004).

In the literature a number of factors have been put forward, both intrapersonal and environmental, that can affect the outcomes and extent of dysfunction after injury. The *cognitive reserve hypothesis* (CRH) holds that intrapersonal factors such as brain size and neuronal and synaptic capacity (Kesler, et al., 2003; Satz, 1997; Stern, 2002), as well as premorbid IQ (Lezak, et al., 2004; Poggi, Liscio, Adduci, et al., 2003) can act as a buffer in the event of brain injury. An example of an environmental influence on recovery after ABI is socioeconomic status (SES) which can further affect recovery in either a positive or negative direction. Certain markers of SES that are of particular interest to the current study are Race or Ethnicity, Level of Education, Quality of Education and Quality of Medical Care.

***The Cognitive Reserve Hypothesis.***

Theories of cognitive reserve emerged out of studies of Alzheimer's disease (AD). The concept of *cognitive reserve* (CR) is that a larger brain (measured by total intracranial volume), which belongs to an individual with a higher IQ and a higher level of education, will be more resilient to injury or illness (Basso & Bornstein, 2000; Kesler, et al., 2003; Starr & Lonie, 2008).

Satz's (1997) threshold model put forward the hypothetical construct of physiological brain reserve capacity (BRC), which utilised brain size or synapse count, and presupposed that there is a threshold up to which damage to the brain does not result in noticeable pathology. Once this threshold has been exceeded, clinical or functional deficits will become apparent. Stern (2002) proposed the model of cognitive reserve which hypothesised that widespread or distributed brain (neural) networks are used by a brain-healthy person when they need to perform at maximum capacity; it is this utilisation of brain networks that compensate for or act as a buffer in the event of brain damage (Stern, 2002).

In an investigation of the effect of injury on brain reserve capacity, Kesler and colleagues (2003) studied 25 participants with TBI using magnetic resonance imaging (MRI) analyses. They examined the relationships between total intracranial volume (TICV), ventricle-to-brain ratio (VBR), level of education, pre-morbid standardised testing scores that were obtained prior to injury, and post-injury cognitive outcomes. TICV was used as an indicator of premorbid brain size, calculated from analyses of the MRI scans. VBR (also calculated from the MRI) was used as an indication of the extent of structural brain damage. The study found that participants with lower post-injury IQ scores had significantly lower TICV values irrespective of severity of injury and manifested a significantly greater change in IQ from pre- to post-injury. Level of education predicted the category of post-injury IQ (≥ 90 or <90), but pre-morbid scores were not predictive of cognitive outcome. The authors concluded that results suggest that a larger pre-morbid brain volume and a higher education level may decrease vulnerability to brain injury (Kesler, et al., 2003).

Scarmeas and Stern (2003) reported epidemiological evidence which confirmed that a lifestyle that is enriched by social and intellectually challenging leisure activities was protective against cognitive decline in the elderly. They also upheld evidence from functional imaging studies which demonstrated that individuals who engage in such activities can better tolerate AD pathology. The authors concluded that certain life activities may result in more functionally efficient cognitive networks which in turn help to delay the onset of clinical manifestations of dementia (Scarmeas & Stern, 2003).

A longitudinal study investigated the effect of cognitive reserve in 659 patients with Alzheimer's Disease (Starr & Lonie, 2008). Participants were assessed at baseline using six cognitive tests. Activities of daily living and pre-morbid level of intelligence were also assessed. Participants were followed up over 78 weeks after starting treatment (a cholinesterase inhibitor). The authors concluded that pre-morbid IQ is an index of cognitive reserve and found support for the hypothesis that cognitive reserve continues to influence cognition after diagnosis of AD. It was also concluded that cognitive reserve appeared to ameliorate cognitive deterioration in AD patients, especially on tests with a high verbal content. Similarly, in an earlier study Basso and Bornstein (2000) followed 155 men with HIV for a year, and found at twelve-month follow up that regardless of disease status (asymptomatic, symptomatic and AIDS) those with above average premorbid IQ either improved over the year or remained unchanged .

The upshot of the CRH in the context of brain injury is that other than idiosyncratic anatomical factors (such as brain size), environment can play a large part in recovery. Persons from a high SES with a more intellectually stimulating lifestyle, more years of education and the resulting greater number of synaptic connections in the brain, would have a certain level of buffering against brain injury. Conversely, those from a low SES background, who live more monotonous lives and are employed in repetitive jobs, with less education, will have a less buffering in the event of a brain injury. Thus, the larger the brain and a higher number of distributed synaptic networks combined with a varied and stimulating premorbid lifestyle, the greater the buffer the individual has in the event of a brain injury. Individuals from a high SES are more likely to have received a superior education, better quality of medical care and would be more likely to live a more stimulating lifestyle than those with a low SES, who would have less education (in terms of quantity and quality), access only to basic medical care and would receive little or no intellectual stimulation. As a result, a recent area of interest in recovery from ABI is socio-economic status.

***Effects of socioeconomic status on recovery from ABI.***

Originally used to describe disparities in the distribution of disease, the term *socioeconomic status* (SES) has replaced 'social class' in the literature when examining notions of stratification such as income, education, occupation and property ownership (Williams & Collins, 1995). The World Health Organisation website contains numerous studies which have found that those with low SES not only tend to be more susceptible to illness and injury, but can expect poorer outcomes and recovery due to low levels of medical care, financial barriers to medical care and general lack of resilience to illness or injury (World Health Organisation, 2010). Specifically with regard to brain injury, Hoofien and colleagues (2002) conducted a factor analysis of the predictive power of socioeconomic variables, severity of injury and age on the long-term vocational outcome of TBI. It was found that the pre-injury SES variables (education and premorbid vocational achievement) predicted long-term cognitive, psychiatric, vocational, and social/familial functioning after TBI (Hoofien, et al., 2002).

Low SES not only places the individual at higher risk for brain injury (Cohadon et al., 2002, cited in Lezak, et al., 2004; Naugle, 1990), but can affect recovery from ABI. For example, a number of studies have found that people of lower SES tend to have fewer financial resources and are less likely to receive rehabilitation. Therefore after sustaining an ABI, low SES individuals are less likely to return as productive members of the community, to be employed (or return to school) and are more likely to have greater levels of comorbidity (Arango-Lasprilla, et al., 2007; Sander, et al., 2009; Sherer, et al., 2003). Studies that have been conducted in the United States concur that low SES is associated with the level of recovery after ABI (Arango-Lasprilla, et al., 2007; Sander, et al., 2009; Sherer, et al., 2003).

There is a paucity of research on ABI in South Africa, despite there being a higher incidence of this type of injury here than in other countries (Bruns & Hauser, 2003). A study by Brown and Nell (1991) revealed that the incidence of traumatic brain injury for the 25 to 44 year age group was higher than the same age group in other countries. The KwaZulu-Natal Department of Health (2010) estimates that 89 000 cases of new TBI are reported every year in South Africa – this estimate does not include victims of stroke or brain injury caused by illness. The most common causes of traumatic brain injury in South Africa are reported to be motor vehicle, bicycle, or vehicle-pedestrian mishaps (more than 50%), falls (approximately 25%) and violence (nearly 20%). Other risk factors include alcohol and drug abuse, violence, contact and extreme sports, driving at high speeds and without seatbelts, driving motor cycles without helmets and construction work. It was also reported that men are twice more likely to sustain a head injury than women (KwaZulu-Natal Department of Health, 2010). Brown and Nell (Brown & Nell, 1991) reported that there are disparities in TBI by race and ethnicity in Johannesburg, where compared to Whites, the rate ratio for Africans was 3.3:1, for Coloureds it was 2.7:1 and for Indians 1.9:1.

In the South African context, research into the return to work of 50 individuals who had sustained an ABI found that there was an overall return to work rate of 56%, including those who returned to downgraded jobs (Watt & Penn, 2000). Less than a third of the sample were able to return to full-time competitive employment. Despite the sample being described as relatively well-resourced, few of the group had received any form of therapy even though the majority had sustained severe injuries (Watt & Penn, 2000). If this is the situation for South Africans who are well-resourced, it is argued that the situation for those who are under-resourced, from a low SES, must be even less favourable. For example, in South Africa, Africans from lower socioeconomic strata have differences in the quality of education (Cavé & Grieve, 2009), access to transport, to medical care, and in quality of accommodation (Baker, 2010; Coovadia, et al., 2009; Shuttleworth-Edwards, Donnelly, Reid, & Radloff, 2004). Thus South Africans from low SES are likely to be at higher risk and have less buffering in the event of brain injury. As the current study focuses on decision-making in survivors of ABI from different socioeconomic levels, research on markers of SES, in particular race, level and quality of education and quality of medical care is discussed below.

***Race and ethnicity.***

The majority of international research that focuses on SES and outcomes of brain injury associates low SES with groups of people who are not of European descent (generally labelled minority groups). Typically outcomes for victims of ABI from low SES, ethnic minority populations in the United States (US) are found to be poorer than those for Whites even after accounting for severity of injury and sociodemographic characteristics. In the literature, the term 'minority groups' when applied to populations in the United States is generally used to describe African-Americans and Hispanics (Arango-Lasprilla, et al., 2007; Gary, et al., 2010; Sander, et al., 2009; Sherer, et al., 2003). By their very nature minorities tend to be less affluent than the mainstream members of a society or culture and can thus be more susceptible to other environmental influences that are known to impair neurodevelopment (Waber, Gerber, Turcios, Wagner, & Forbes, 2006). These can include physical risks (such as toxic exposures, pre- and perinatal risk, and malnutrition) as well as negative environmental circumstances (such as family disorganization, parental depression, exposure to violence, or stress; Waber, et al., 2006). Negative influences such as these can be extrapolated to the majority of the South African population who struggle with poverty, non-delivery of essential services, less than adequate medical care and disparities in education (Baker, 2010; Brown & Nell, 1991; Cavé & Grieve, 2009; Coovadia, et al., 2009; Shuttleworth-Edwards, Kemp, Rust, et al., 2004)

A study conducted in the US evaluated functional outcomes of individuals with TBI at admission, discharge and one year post-injury with the aim of determining differences in functional outcomes between Whites and minorities (African Americans and Hispanics; Arango-Lasprilla, et al., 2007). Functional outcomes were measured using the Disability Rating Scale (DRS), Functional Independence Measure (FIM), Community Integration Questionnaire (CIQ) and the Extended Glasgow Outcome Scale (GOS-E). The authors found that at discharge, the minority groups scored significantly worse than Whites on the DRS and the FIM. At one-year follow up, after controlling for socio-demographic and injury factors that may have influenced outcomes, minority TBI survivors had significantly worse outcomes on all measures (DRS, FIM, CIQ and GOS-E) when compared to Whites (Arango-Lasprilla, et al., 2007)

In a review of racial and ethnic differences in post-injury outcomes after brain injury, Gary and colleagues (2010) found that with regard to psychosocial outcomes, seven out of eight articles concluded that minorities in the United States had more problems with regard to returning to work and being productive than Whites. Six studies reviewed identified differences between minorities and Whites on CIQ scores revealing that up to at least one year post-injury, minorities fared worse than their White counterparts even after sociodemographic and injury characteristics had been taken into account. Two out of four articles concluded that African Americans had lower life satisfaction when compared to Whites (Gary, et al., 2010).

In the same review, Gary and colleagues (2010) found that only two studies examined race and/or ethnicity with regard to disparities in neuropsychological outcomes after TBI between Whites and minorities. Both studies pointed to differences in cognitive and neuropsychological test performance, with African Americans generally performing more poorly than Whites. The available literature indicated increased depression, poorer social functioning outcomes and increased post-traumatic stress among African Americans with TBI (Gary, et al., 2010).

An earlier US study (Sander, et al., 2009) compared the influence of race or ethnicity and income on re-integration into the community at approximately six months post-injury. Participants (*n* = 151) had mild to severe TBI and were comprised of African Americans, Hispanics and Whites. It was found that there were racial/ethnic differences in community integration even after accounting for income; income was in fact more predictive than race/ethnicity for certain aspects of community integration (such as a sense of belonging or of being a productive member of the community). It was further found that African Americans suffered worse outcomes after ABI than did Whites (Sander, et al., 2009). This echoes the findings of the studies and review described above (Arango-Lasprilla, et al., 2007; Gary, et al., 2010) which found that in the US, low SES in survivors of TBI was associated with functionally worse outcomes. It is therefore apparent that SES does impact recovery from a brain injury such that high SES has a buffering effect on the brain should an individual sustain a brain injury.

In South Africa, the issue of race is also relevant to recovery from ABI as the country is still divided economically along racial lines. The majority of Black South Africans tend to be poor, with inadequate education, and dependent upon public sector healthcare (Coovadia, et al., 2009). Another marker of SES is the level or years of education. This is discussed in the next section.

***Level of Education.***

Not only is a higher level of education argued to be physiologically neuroprotective in people who have suffered a brain injury (Scarmeas & Stern, 2003), but the lower-paid menial jobs that are available to those with fewer years of education can present a higher risk for TBI (Cohadon et al., 2002; cited in Lezak, et al., 2004; Naugle, 1990). The majority of studies indicate that level of education does indeed play a role in recovery from ABI. For example, one study reported that factors positively related to return to work in stroke patients were high education level, white-collar employment and age younger than 65 years, whereas the significant negative predictor of return to work was the severity of the stroke (Treger, Shames, Giaquinto, & Ring, 2007). In a study of the test performance in clinical groups, it was found that in individuals with brain injury, those with more years of education performed more favourably on neuropsychological tests (Sherrill-Pattison, Donders, & Thompson, 2000). Plumet and colleagues (2005) found that in a group of women, level of education had an effect on WCST performance in that age effects were apparent in those with less education. In contrast to the aforementioned studies, research by Green and colleagues (2008) concluded that although level of education and premorbid IQ showed no evidence of playing a recuperative role in ABI, only premorbid IQ may have a possible buffering influence. This could however have been due the study participants having sustained moderate to severe brain injury which would exceed the buffering effect of level of education.

One study of 500 individuals with Alzheimer's Disease found that level of education had an influence on the rate of cognitive decline, however another study of Alzheimer's sufferers contradicted this finding in that higher premorbid IQ, but not education, protected against decline on global cognitive and functioning outcomes (Starr & Lonie, 2008). It could be argued that premorbid IQ and level of education are interdependent, that is individuals with a higher IQ would be more inclined to study further and would thus be more likely to enjoy the buffering effect of higher IQ as well as that of level of education. An area of recent interest both in South Africa and internationally is quality of education and its impact both on recovery from ABI and on neuropsychological test performance.

***Quality of Education.***

It has been found that quality of education can have an effect on neuropsychological test results in individuals without brain injury (Cavé & Grieve, 2009; Shuttleworth-Edwards, Donnelly, et al., 2004; Walker, Batchelor, Shores, & Jones, 2010), but there is a little or no research on the effect that quality of education has on recovery from ABI. It has been suggested that individuals who have received a better quality of education are more likely to perform better on academic and neuropsychological tests, as they are more familiar with the testing situation.

Quality of education has an effect on *test-wiseness*, in that individuals brought up and educated in a Western milieu would be more comfortable with test-taking procedures than people from a non-Western culture (Nell, 2000). Nell maintains that "[t]est-taking skills are so taken for granted in Western society that it is difficult to grasp the extent to which they are absorbed rather than explicitly taught" (Nell, 2000, p. 3). Shuttleworth-Edwards and colleagues (2004) suggest that the procedural factor of test-taking skills (test-wiseness), has a significant effect on IQ performance over and above pure language ability and crystallised knowledge.

In a study examining the differences in neuropsychological test results in bilingual individuals with moderate to severe brain injury, Walker (2010) observed that not only the level but the quality of education had an effect on test-taking or test-wiseness. Similarly, Kennepohl and colleagues (2004) commented in their conclusion that when conducting a neuropsychological assessment with an African American client one should be aware of variables of potential importance such as level and quality of education. In addition to quality of education providing a buffer to the effects of ABI, quality of medical care also can have an impact on the extent of recovery.

***Quality of Medical Care at time of injury.***

Studies conducted in the US have found that there are disparities in medical care between Whites and minority groups (African-Americans and Hispanics). In a recent comprehensive review of the literature, Gary and colleagues (2010) examined racial differences in post-injury outcomes. The authors found disparities in the areas of treatment outcomes. Seven of the nine articles reviewed concluded that African Americans and Hispanics (compared to Whites) were less likely to receive the highest quality of emergency room care, less likely to be referred for further rehabilitation or specialized care after inpatient treatment, and less likely to receive additional rehabilitative therapies. The majority of the studies reviewed controlled for demographics, injury-related variables and functional status prior to reporting final results. Notwithstanding discrepancies as a result of the timing of measurement of functional outcomes, the differences were apparent after one year and up to five years post-TBI (Gary, et al., 2010). The situation in the United States could arguably be paralleled in South Africa, where there are disparities between private and government medical care (Baker, 2010; Coovadia, et al., 2009). For example, a study at Groote Schuur Hospital in Cape Town found that out of 96 patients with head injury, 49 experienced at least one recorded preventable event of hypoxia or hypotension, and seventeen had an intracranial haematoma requiring evacuation, yet none were evacuated within four hours of injury (Reed & Welsh, 2002).

Up to this point, the effects of SES on recovery from brain injury have been discussed. However, high or low SES can also affect neuropsychological test scores in healthy individuals.

**SES and neuropsychological test performance in healthy South Africans.**

There is a trend for the majority of South Africans to produce neuropsychological test scores that are inferior to the standardised norms, even in individuals who have not sustained a brain injury. There is also a trend for intact South Africans from low SES groups to produce scores inferior to those produced by South African individuals from high SES groups on neuropsychological tests. In South Africa there is a relationship between low SES and race such that the majority of Whites tend to be middle class and the majority of Blacks to be poor. In 1998, Thabo Mbeki described South Africa as being divided into two nations:

> *One of these nations is white, relatively prosperous [and]...has ready access to a developed economic, physical, educational, communication and other infrastructure...The second and larger nation of South Africa is black and poor, [and lives]...under conditions of grossly underdeveloped economic, physical, educational, communication and other infrastructure* (Hansard, citied in Seekings, 2008, pp. 6-7).

In South Africa this disparity in living standards is paralleled by differences not only in neuropsychological test scores between SES levels, or level of education, but also in quality of education (Cavé & Grieve, 2009; Shuttleworth-Edwards, 2010; Shuttleworth-Edwards, Donnelly, et al., 2004; Shuttleworth-Edwards, Kemp, et al., 2004; Skuy, Schutte, Fridjohn, & O'Carroll, 2001). This is the legacy of inequities in the quality of education during the Apartheid era and the resulting lack of test-wiseness in certain groups of South Africans. According to the CRH, level of education can enhance or detract from the buffering effect that education provides in the event of an ABI. Quality of education can also affect this buffering effect. Essentially this means that in the event of a brain injury, the prognosis is poorer for low SES South Africans than for those from a high SES.

Almost sixteen years after the democratic elections of 1994 the lingering after-effects of Apartheid have perpetuated adverse social conditions for the African majority, including significant levels of unemployment, very limited and disorganised education facilities, unsatisfactory living conditions, and only basic medical care. With regard to education in the 'new' South Africa, the majority of Whites together with middle-class African, Coloured and Indian children attend either Private or Model C-type schools which have been modelled on the

British public school system (Shuttleworth-Edwards, Kemp, et al., 2004; Skuy, et al., 2001). The majority of African children in South Africa attend schools that belonged to the former Department of Education and Training (DET), the statutory body that was responsible for African education during Apartheid (Skuy, et al., 2001). Over and above a shortage of basic facilities, previously disadvantaged schools typically do not have a library or computers for learners to use (Cavé & Grieve, 2009; Shuttleworth-Edwards, Kemp, et al., 2004). The difference in quality of education between the advantaged Private/ Model C-type schools and the disadvantaged former DET schools is reflected in differences in the annual Grade 12 results produced by the different types of schools, especially in the subjects of mathematics and physical science (Kahn, 2004). This is noteworthy, as quality of education (between advantaged Private/ Model C-type education, versus disadvantaged former DET education) has had a significant effect on neuropsychological test scores and IQ (Cavé, 2008; Shuttleworth-Edwards, 2010). A number of South African studies have been conducted in the past decade comparing the neuropsychological test results of those who attended advantaged Private/ Model C-type schools against the scores of those who attended former Department of Education and Training (DET) disadvantaged schools.

Cavé and Grieve (2009) examined the differences in quality of education on neuropsychological test performance. Twenty learners from two private schools (Group A) were compared to twenty learners from two government schools (Group B), all from within the Johannesburg area. Group A scored significantly better than Group B on all tests at a 1% level of significance. The authors concluded that the results suggested a relationship between quality of education and neuropsychological test performance, especially on tests of executive functioning. Other socio-cultural variables such as home language, general school performance, parental level of education, and parental occupation were put forward as possible confounding factors (Cavé & Grieve, 2009). However it has been argued that these are in themselves markers of an inadequate and inferior education (Shuttleworth-Edwards, Kemp, et al., 2004) and consequently of low SES.

An earlier study by Shuttleworth-Edwards and colleagues (2004) examined the effects of language, level of education and quality of education on IQ performance. Participants were stratified into two ethnic/language groups (White/English first language and Black/African first language), two factors of level of education (Grade 12 and Graduate) and two levels of quality of education (advantaged and disadvantaged). The Wechsler Adult Intelligence Scale (WAIS-III) was administered. Results revealed that (1) Grade 12 learners performed poorly compared to Graduates across both Black/African groups and (2) those from previous DET schools performed more poorly than those from Private/ Model C-type schools in the Black/African first language group. With regard to quality of education, scores were significantly lower for participants who had received poor quality former DET education compared to good quality Private/Model C education across all subtests, Factor Indexes and IQ scores. It was concluded that quality of education had a greater effect on neuropsychological test results than did level of education within the black African first language group with significantly lower scores for poor quality of education (Shuttleworth-Edwards, Kemp, et al., 2004).

Skuy and colleagues (Skuy, et al., 2001) examined the performance of urban African high school learners on a neuropsychological test battery. Two groups were tested: a group of 100 Soweto learners from Grades 8 to 12, and a second group of 152 Grade 6 Soweto learners. All scores were significantly lower for each age group in comparison to the published norms. As lower scores were attained in both verbal and non-verbal tests, the authors argued that language has a considerable effect on test performance as the group was raised in a multilingual environment and educated in a language other than their mother tongue. Highly significant differences as a function of scholastic grade that far outweighed the influence of the age variable were also found (Skuy, et al., 2001).

It is not only the age of the participant, nor their education level that has an impact on neuropsychological test scores, but the quality of education received can also have a significant effect, especially in the South African context. Studies have shown that in South Africa level and quality of education can have an adverse effect on neuropsychological test performance. Shuttleworth and colleagues (2004) have argued that fewer years and inferior quality of education are markers of low SES. In a similar vein it has been posited that race in South Africa is a marker of SES (Seekings, 2008). Quality of medical care is a marker of both race and SES in South Africa (Baker, 2010; Coovadia, et al., 2009). Research has indicated that a lower SES is associated with lower recovery rates after ABI. It has also been shown that people with a brain injury tend to fare less well on tests of decision-making. Therefore this study aims to demonstrate that in individuals who have sustained ABI, those from a low SES context will fare worse on tests of decision-making than those from a high SES background.

## Rationale for the Current Study

Research has demonstrated that performance on tests of decision-making is compromised in those with brain injury. SES has also been shown to have an impact on neuropsychological test outcomes.

Race, level and quality of education, and standard of medical care are considered to be markers for low SES in South Africa (Baker, 2010; Coovadia, et al., 2009; Seekings, 2008; Shuttleworth-Edwards, Donnelly, et al., 2004). Quality of education (a marker for SES) has been shown to have an impact upon neuropsychological test scores. It therefore follows that low SES will have an impact on neuropsychological tests that measure decision-making. What is not known is whether SES, particularly with regard to race, level and quality of education, and quality of medical care, will impact upon decision-making styles equally in those who have sustained a brain injury. By measuring decision-making as a part of executive function in those with ABI, information will be gained that can assist in utilising appropriate interventions for prevention and recovery that could be tailored to individuals of all strata of South African society.

On the basis of the above literature review, it appears that low SES can have a detrimental effect on cognitive function. The general hypothesis of this study, therefore, was that participants with ABI from a high SES background would perform better on tests of decision-making (actor-centred, emotional and veridical) than participants with ABI from a low-SES background. Breaking down the general hypothesis into sub-hypotheses resulted in the following four hypotheses: (1) there would be a difference on outcomes on tests of decision-making (actor-centred, emotional and veridical) between those with ABI from the different race groups, (2) participants with ABI who have a higher level of education would perform better on tests of the three decision-making approaches than participants with a lower level of education, (3) participants with ABI who have received a good quality of education would perform better on tests of the three decision-making approaches than participants with a poor quality of education, and (4) those who had access to a better quality of medical care would perform better on tests of the three decision-making approaches than participants who had poor quality of medical care.

However, it should be specifically acknowledged that the component variables of SES selected as relevant to this study are potentially interdependent. In particular, in South Africa the construct of Race also encompasses certain social, educational, and economic conditions among others. The other independent variables in this study (Level of education, Quality of Education and Quality of Medical Care) are part of the aforementioned conditions. It is therefore likely that comparison between the two Race groups has elicited results that will also reflect the impact of these conditions.

The TTT has been used to assess executive function, and as there is minimal input from the examiner it is argued that this test is appropriate to use as an assessment of actor-centred decision-making in neurologically impaired individuals. There has been a large amount of research on emotion-based decision-making using the IGT. The WCST as a test of decision-making typically embraces a veridical process. Thus it was decided to use the TTT to measure actor-centred decision making, the IGT to measure emotion-based decision making, and the WCST to measure veridical decision-making in individuals with ABI.

# Method

## Participants

Participants for this study were purposively selected from individuals with acquired brain injury who attend therapy groups at Headway Gauteng, a non-profit, non-governmental organisation established to assist individuals with brain injury and their families. Headway Gauteng provides a holistic and multidisciplinary approach to recovery from brain injury by providing group therapy for those with ABI which includes the disciplines of Psychology, Speech Therapy, Occupational Therapy, Physiotherapy and Biokinetics. Attendance days are divided with regard to the functioning and abilities of attendees with dedicated days for high, intermediate and low functioning abilities. At the time of the study, Headway Gauteng had two branches, the Head Office situated in Hyde Park, Johannesburg, and an outreach programme in Alexandra (Khomelela). Hyde Park attendees are mixed in that some pay for therapy days and others are partially or fully sponsored. All attendees at Khomelela are fully sponsored. Hyde Park and Khomelela are therefore socioeconomically diverse with Hyde Park consisting of high SES attendees where Khomelela has low SES attendees. However, it should be emphasised that the participants from the two branches were not seen as two samples – rather, this was a single sample that was selected from the different branches in order to obtain a pool that was socioeconomically diverse.

Figure 1: Therapy Equipment – Headway Hyde Park

Figure 2: Therapy Equipment – Headway Khomelela

Figure 3: Computer Equipment – Headway Hyde Park

Figure 4: Main Entrance – Headway Hyde Park

Figure 5: Main Entrance – Headway Khomelela

The Psychology discipline at Headway Hyde Park extends to a support group (the Headway Friendship Circle or HFC) for family members of individuals with ABI as well as for current and past attendees. Members of HFC who had previously attended Headway therapy groups were also invited to participate in the study.

Permission to conduct the study at Headway Gauteng was sought from and granted by Ms Talita Da Costa, the supervising Clinical Psychologist (Appendix E). Ms Da Costa supervised the selection of participants. For ethical reasons it was decided that only attendees placed in the high functioning groups would be approached to take part, as only this group would be capable of understanding and signing the informed consent. High functioning groups are comprised of individuals who are able to participate in tasks requiring a reasonably high level of cognitive ability and who show insight into their condition.

The exclusion criteria were: younger than 18 or older than 65 years, a premorbid history of psychiatric illness or substance abuse, a level of physical disability incompatible with a participant's ability to complete the tasks, and inability to comprehend and sign the informed consent. All participants had sustained an ABI, either from medical causes or from trauma.

Due to the small sample size it was decided to include the participants from HFC with the Hyde Park group. The demographic profile of the sample is summarised in Table 4.1. All participants were provided with a participant information sheet (Appendix A) prior to taking part in the study and all were asked to sign informed consent (Appendix B).

## Research Design

The study was a non-experimental, cross sectional design with the aim of exploring post-injury decision-making in participants rather than manipulating the independent variables. A set of measurements was collected with regard to the variables of interest and no attempt was made to change or alter these variables. There was no attempt made to establish causation; rather the focus of this study was to examine differences in performance in terms of the independent variables.

## Instruments

Each participant's demographic information and socio-economic status data was gathered by means of a questionnaire. The Tinker Toy Test (TTT; Lezak, et al., 2004) was used to assess actor-centred decision-making. The practice round of the computerised Stroop Test (Stroop; Mueller, 2010) was used as a control to ascertain the participant's familiarity with computers and establish computer response time as the next two measures were administered using a computer. The computerised version of both the Iowa Gambling Task (IGT) and the Berg Card Sorting Test (BCST; Mueller, 2010) were used to assess emotion-based decision-making and veridical decision-making respectively. All three computerised tests, namely the Stroop, IGT and BCST were part of the PEBL Test Battery which is 'freeware' available on the internet

(PEBL; Mueller, 2010). The rationale behind using computerised assessments of emotion-based and veridical decision-making was to try and maintain consistency in the testing method as far as possible throughout the assessment. It was assumed that the majority of participants would be computer literate as personal computers are provided both at Headway Hyde Park and Khomelela for the use of the attendees.

**The Demographic and Socioeconomic Status Questionnaire.**

Section A of the Demographic and Socioeconomic Status SES Questionnaire (SES Questionnaire; Appendix C) was developed for the current study and used to gather pertinent demographic details: gender, race, age, type of education, level of education, left- or right-handedness, type of injury, time since injury, length of coma, duration of post traumatic amnesia and access to medical aid or private medical care. Section B was based on the *Birth to twenty mobile bone health: 16th year adolescent community SES Questionnaire* developed by the University of the Witwatersrand Department of Paediatrics and Child Health (University of the Witwatersrand Department of Paediatrics and Child Health, 2006). This section was designed to assess the participants' SES by asking questions about their neighbourhoods: mix of living standards, main type of housing, type of security, neighbourhood facilities, shopping venues and neighbourhood problems. All Section B items were scored so that a lower score indicated lower SES.

The final version of the questionnaire consisted of eighteen closed-ended questions (Section A, eleven questions; Section B, seven questions). It was anticipated that on average it should take twenty minutes to complete.

**The Tinker Toy Test (TTT).**

The TTT was developed by Lezak in 1982 and utilises components of the Tinker Toy construction set (Koss, et al., 1998). The test has no predetermined solution and is a self-structured task that gives individuals the opportunity to demonstrate a level of executive functioning: goal-setting, planning and follow-through (Lezak, et al., 2004). The participant is instructed to make whatever they wish from the 50 assorted pieces selected from a standard Tinker Toy set described in Table 1. The current study used the Jumbo set in which the pieces are larger than those from the standard set but otherwise identical. The larger pieces were easier to manipulate for participants with hemiplegia.

Table 1:

*Components Used in the Tinker Toy Test*

| **Wooden Dowels (*n*)** | **Rounds (*n*)** | **Others (*n*)** |
|---|---|---|
| Orange (4) | Knobs (10) | Connectors (4) |
| Green (4) | Wheels (4) | Caps (4) |
| Red (4) | | Points (4) |
| Blue (4) | | |
| Yellow (6) | | |

In order to administer the test, the 50 Tinker Toy pieces (Figure 3.6) are mixed up then placed on a tray in front of the participant who is told: "Make whatever you like with these. You will have at least five minutes and as much more time as you wish to make something" (Lezak, et al., 2004). The participant is given encouragement but no guidance. Once the participant has completed a construction, the examiner asks the participant to name it. If the participant is able to name the object, the name is evaluated as to whether it is appropriate to the construction (Lezak, et al., 2004). Executive functions such as the ability to formulate a goal, and then to plan, initiate and carry out a complex activity to achieve that goal can contribute to high scores on the TTT. Persons who have an impaired ability to formulate goals or plan but who are able to initiate an activity may employ a greater number of pieces but unlikely to be able to name the construction, or may give it an inappropriate or ad-hoc name (Lezak, et al., 2004).

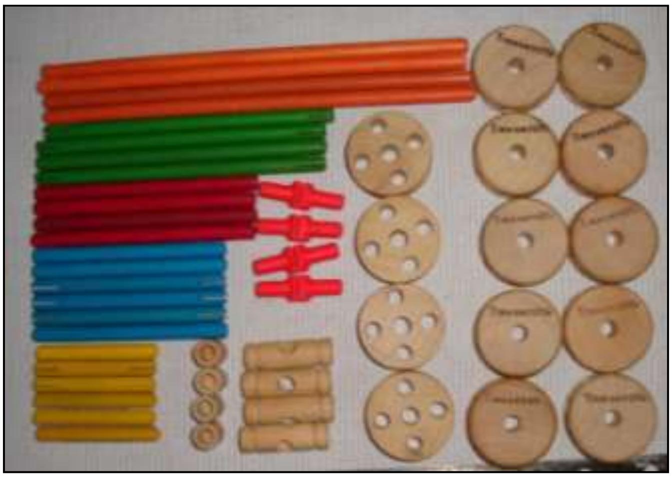

Figure 6: Components Used in the Tinker Toy Test

At the completion of the construction, a complexity score (*comp*) ranging from 0 to 12 points is awarded (Kesler, et al., 2003) which includes seven subscores (Appendix D): *mc* (whether or not the participant made any constructions: 1 point), *np* (total number of pieces: 1 to 4 points), *name (*whether the construction was given a name appropriate to its appearance and at what stage: 0 to 3 points), *mov* (mobility and moving parts: 0 to 2 points), *3d* (three dimensional: 1 point), *Stand* (free standing: 1 point) and *Error* (performance error, negatively scored; Lezak, et al., 2004). As the participants had different levels of injury severity, the *np* subscore as well as the overall *comp* score were used as dependent variables.

**The Stroop Test.**

The computerised version of the Stroop Test from the freeware PEBL Test Battery (Mueller, 2010) was used for this study. The participant's response time in the Practice Round consisting of 50 trials was used as a control variable to establish the level of the participant's computer literacy and computer response time.

The participant sits before the computer screen upon which the following instructions are displayed:

> *You are about to be tested on how well you can read words and the colours they appear in. We will start with a practice round. Press any key to begin.*


Figure 7: Computerised Display for the Stroop Practice Round

Once a key is pressed, a screen is displayed with the legend at the bottom: "[1] red [2] green [3] blue [4] yellow". The word 'red' is in red font, 'green' in green font, 'blue' in blue font and 'yellow' in yellow font. In the centre of the screen the stimulus is displayed, either the word 'red', 'green', 'blue' or 'yellow', with each word displayed in the matching coloured font (See Figure 3.7 above). The participant is required to press the corresponding number key on the keyboard, for example '1' for red, '2' for green, and so forth.

If the participant presses the wrong key, the word 'INCORRECT' is briefly displayed on the screen in black font below the stimulus. After 50 trials, the following message is displayed:

*Identify Word Name.*

*Great. Now you will be tested on how well you read words. Press the correct key [1-4] based on the name of the word in the center of the screen. Ignore the color that the word is printed in. Press any key to continue.*

At this point the participant was told by the test administrator that they had completed the task.

**The Iowa Gambling Task (IGT).**

The computerised version of the IGT used in this study was a component of the PEBL Test Battery. The original program code was modified by the researcher to display the amounts won or lost in South African Rand rather than US Dollars. After the test administrator has entered the participant identification code, the second screen displays the following text:

> *You are about to take part in a game where you gamble with play money. You will start with a R2000 loan.*
>
> *On each trial, you will select a card from one of four decks by clicking on it with the mouse. After you select each card, you will be given a reward and possibly be required to pay a penalty.*
>
> *Your goal is to maximize the profit on your R2000 loan, and you may choose from any deck at any time to do so.*

The participant is instructed to click the mouse button. The next screen has the heading: "Select the deck by clicking with the mouse". Underneath the text and across the centre of the screen are four decks, numbered 1 through 4. Below the decks the net total of wins and losses is displayed. At the beginning of the game the total reads "R2000". At the bottom of the screen is a scale from -1000 to 5000 in increments of 1000, with a green line from 0 to 2000 that provides the participant with a visual illustration to of their balance (Figure 3.8).

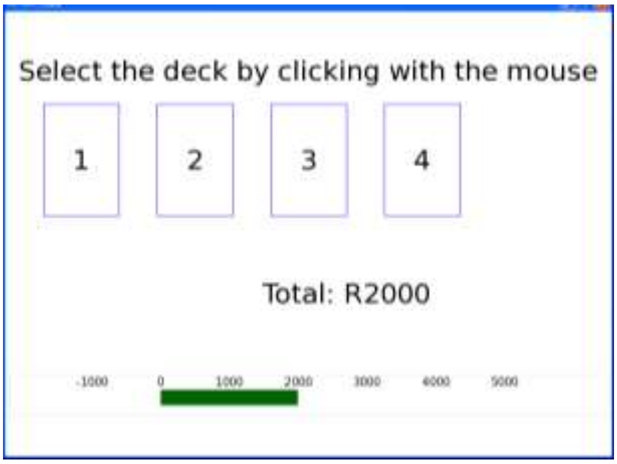


Figure 8: Iowa Gambling Task

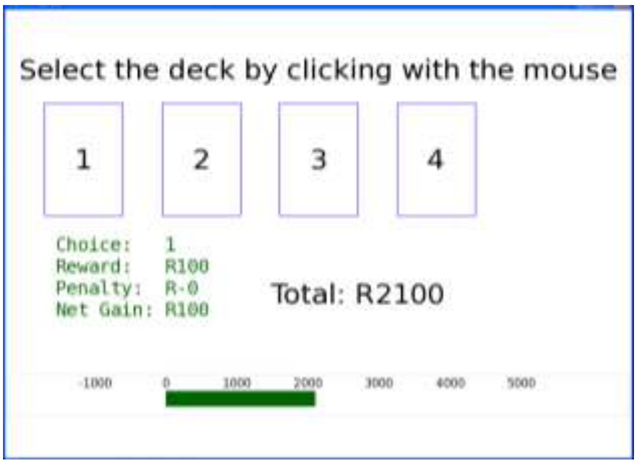


Figure 9: Gain/Loss Information in the IGT

Each time the participant clicks on a deck, the chosen deck, reward amount, penalty amount and net gain are displayed. The balance changes to reflect the net loss or gain. If there is a net gain, the font is displayed in green, if a net loss the font is red. Should the participant break even (the reward is equal to the penalty), the font is black (Figure 3.9).

The game consists of 100 trials after which a message is displayed:

*Thank you for playing the game. You earned (lost) a total of R... You may now leave. Please alert the experimenter that you are done. Press mouse button.*

**The Berg Card Sorting Test (BCST).**

The BCST is the computerised version of the Wisconsin Card Sorting Test (WCST) available as part of the PEBL Test Battery (Mueller, 2010). The first screen displayed has the following text:

*You are about to take part in a game in which you need to sort or group cards based on the pictures appearing on them. To begin, you will see four piles of cards. Each pile has a different number, colour, and shape.*

The participant is instructed to click the mouse button to move on to the next screen. This screen displays the four categories or decks. Category 1 has one red triangle, Category 2 has two green stars, Category 3 has three yellow crosses and Category 4 has four blue circles. Underneath the four categories depicted, there is the following text:

*You will also be shown a whole lot of cards and you need to decide which pile each card belongs to. Click on a pile with your mouse pointer to choose the pile each new card belongs in. The correct answer depends upon a rule, but you will not know what the rule is. But, the computer will tell you on each try whether or not you were correct.*

The participant is instructed to click the mouse button to proceed to the next screen. The display on this screen is the same as the previous one, but the text now reads:

*Finally, the rule may change during the task, so when it does, you need to figure out what the rule is as quickly as possible and change with it. Click the mouse button to begin*

After the mouse button is clicked, the stimulus is presented on the screen, with the instruction “Click pile to sort card” (Figure 3.10).

The participant needs to decide whether to sort the card by colour (Rule 1), by shape (Rule 2) or by number (Rule 3). When the participant clicks on a category, the message “Correct!” (in green font) or “Incorrect” (in red font) is displayed briefly.

During the task a set of 64 stimuli are presented twice giving a total of 128 trials. The order of the rules presented is Rule 1 – Colour (red, green, yellow and blue); Rule 2 – Shape (triangle, star, cross and circle); and Rule 3 – Number (1, 2 3 and 4). Each category is continuously presented until the participant has achieved ten correct trials in a row. The next rule now comes into force (Mueller, 2010). If the participant continues to respond incorrectly, the number of trials per category is increased. After 128 trials have been presented, the message “You may now leave. Please alert the experimenter that you are done. Click mouse to finish” is displayed on the screen.

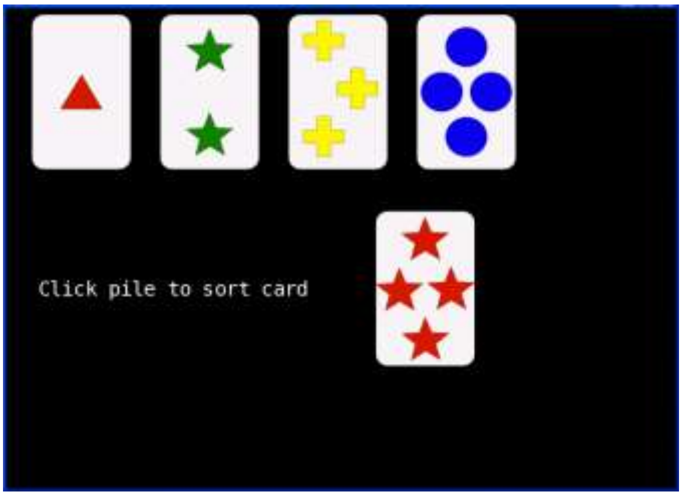


Figure 10: BCST Stimulus and Categories

The BCST computerised version of the WCST does not compute the following results which are typically used in the assessment of executive function: Failure to Maintain Set, Learning to Learn, and Percent Conceptual Level Responses. Because of this, these variables were omitted from the statistical analyses.

Age effects have been found for the WCST, but these are largely inconsequential before the age of 70 (Lezak, et al., 2004). Education has been shown to affect the outcome as has gender (Boone, et al., 1993). Studies using patients with brain disorders have revealed a *failure to maintain set* score, but it has been argued that the reliability of this is low (Lezak, et al., 2004). The test-retest reliability of the WCST was shown to be 0.63, with half of the correlations at or below 0.34. However this result is based upon the testing of brain-intact individuals, which implies that once a participant has deduced what the current strategy is, he or she will perform well both on the initial exposure to the task as well as on subsequent exposures(Lezak, et al., 2004).

Although functional neuroimaging studies have generally supported the role of the frontal lobes in this task, results are contradictory. Whereas some studies reported that those with frontal lobe damage completed the least number of categories, other studies have found that those with frontal lobe damage did not differ from normal controls (Lezak, et al., 2004). However, Stuss and colleagues (2000) found that when compared to individuals with posterior lesions, those with frontal damage made more perseverative and loss-of-set errors. It has been reported that the WCST (and by extension, the BCST) is especially sensitive to diffuse damage (Axelrod, Goldman, Heaton, et al., 1996; Robinson, Heaton, Lehman, & Stilson, 1980)

## Pilot Study

After receiving clearance (Protocol Number H100 518) from the University of the Witwatersrand Human Research Ethics Committee (Non-Medical) a pilot study was conducted with post graduate psychology students ($n$ = 8). Pilot study participants were all required to sign informed consent. All measures were administered and feedback was elicited regarding the presentation of the tasks and the SES Questionnaire.

Consultation with pilot study participants resulted in the order of task presentation for the main study: (1) the SES Questionnaire, (2) the TTT, (3) the Stroop Practice Round, (4) the

IGT, and (5) the BCST. There was consensus that the TTT was the least threatening task and served to help the participant feel comfortable in the test setting. The practice round of the Stroop was the first computerised task administered in order to elicit a baseline computer response time. The rationale for administering the IGT before the BCST was that participants are told to discover the strategy behind the BCST and if this is administered before the IGT the participant is primed and tries to find a 'strategy' behind the IGT, possibly confounding the results.

In order to ascertain which questions from the SES Questionnaire would differentiate high from low SES, the SES Questionnaire alone was administered to domestic workers at Headway Gauteng (*n* = 4). As a result, some questions were changed and a number of other non-differentiating questions were eliminated with the aim of keeping the questionnaire as short as possible.

## Procedure

A poster was displayed at Headway Hyde Park requesting volunteers for the study. Previous attendees at Headway Hyde Park were addressed at a meeting of the HFC and asked if they would be prepared to participate in the study. Three individuals from the HFC volunteered to participate.

The files of Hyde Park attendees from high-functioning activity days were perused to ensure whether or not they had signed Headway's indemnity form, or had progressed to the point where they were capable of giving informed consent. For example, some attendees have been coming to Headway for five years or more and over time have progressed from the low functioning groups to the high functioning groups. The starting point for possible participants from Khomelela was a list of individuals who had been identified as suitable candidates for a neuropsychological assessment. The files of attendees on this list were perused in order to ascertain which persons would be able to understand and sign the informed consent document.

A list of possible participants was then drawn up for each branch (Hyde Park: $n$ = 27; Khomelela: $n$ = 20).

Once a list of possible participants had been drawn up, each person was individually approached, the scope and purpose of the study was briefly explained and their participation in the study was requested. Each possible participant was also given the Participant Information Sheet (Appendix A) to read at their leisure. Possible participants were followed up within a week and asked whether or not they would like to take part in the study.

The penultimate sample size was 27 participants (Hyde Park: $n$ = 13; Khomelela: $n$ = 11; HFC: $n$ = 3). One participant from Khomelela was unable to understand the instructions for the Stroop practice test and his participation was terminated. A Hyde Park participant consented to take part but then was excused after complaining of fatigue. This resulted in a final sample size of 25 participants across all three groups.

Testing took place in one of the therapy rooms at Headway Hyde Park or Headway Khomelela, in an environment that was familiar to both groups of participants. Volunteers from the HFC were tested at the Hyde Park premises. All tests were administered in the morning, as it was found that participants with brain injuries had the tendency to feel fatigued in the afternoons which may have had an effect on their test performance.

The scope and purpose of the study was explained to participants and it was emphasised that participation was voluntary and that they could withdraw at any time without prejudice. Participants were verbally taken through the informed consent and were then requested to sign the form. The SES Questionnaire was verbally administered in order to more fully explain any items that were unclear to the participant. Responses were noted by the researcher.

The first test to be administered was the TTT as it was reported by pilot study participants that this made the testing situation more comfortable and amenable for the participant because it could be perceived as 'fun'. This was followed by the Stroop, the IGT and then the BCST. Each computerised test was preceded by a practice session as advised by Nell (2000), who recommended that extended practice be allowed for all participants who are not fully test-wise, despite having completed 12 years of formal education. On the computer based tests, participants were first shown what to do by the researcher, and then allowed to practice for up to five trials before the test was restarted (Nell, 2000). This was felt to be not only appropriate for participants who had received their education under the DET or at former DET schools, but also for those from Private/Model C-type schools as all had suffered brain injuries. As it was beyond the scope of this study to determine if a participant had suffered impairment to his or her visual or auditory memory, all screen texts and instructions for the Stroop, IGT and BCST were read out to the participant as they were displayed.

### Variables

Demographic and SES variables were collected by means of the SES Questionnaire. The output from the Stroop was in the form of a text file. The data included the Participant ID, Trial Number, Colour Displayed, Colour Response, Absolute Time (in milliseconds) and Response Time (milliseconds). The variables of interest were Participant ID and Response Time. The output for the IGT was a text file with the following fields: Participant ID, Trial Number, Chosen Deck, Reward Amount, Penalty Amount, Net Gain or Loss, Running Total, Absolute Time (in milliseconds) and Reaction Time (milliseconds). The variables of interest were Participant ID and Net Gain or Loss.

Two text files were output by the BCST program. One consisted of the raw data with the variables Participant ID, Trial Number, Run, Rule (1, 2 or 3), Previous Rule, Colour, Shape, Number, Participant Response, Correct Response (0 or 1), Last Correct Response, Correct Colour (0 or 1), Correct Shape (0 or 1), Correct Number (0 or 1), Perseverative Response (0 or 1), Perseverative Errors (0 or 1), Absolute Time and Response Time (both in milliseconds). A summary text file was also generated (Figure 3.11) which provided the following data:

Categories Completed/Experienced, Number of Trials, Correct Responses, Total Errors, Perseverative Responses, Perseverative Errors, Non-Perseverative Errors, Unique Errors, Trials to Complete First Category, and Perseverative Runs. The data from the summary text file were used.

The variables of interest were Participant ID, Categories Completed/Experienced, Number of Trials, Total Correct Responses, Total Errors, Total Perseverative Responses, Total Perseverative Errors, Total Non-Perseverative Errors, Trials to Complete First Category, and Total Perseverative Runs. The variable Categories Experienced is the total number of categories experienced by the participant, whether or not the last category had been completed. The variables that pertain to perseveration (Total Perseverative Responses, Total Perseverative Errors and Total Non-Perseverative Errors) refer to categories experienced after the first category, which could amount to a maximum of ten categories. Perseverative Runs is the number of error perseverations in a row at the beginning of each new category.

```
---------------------------------------------------
Statistic                          Value
---------------------------------------------------
1. Categories Completed/Experienced: 2 / 3
2. Number of Trials:                 128
                        ---------------------------
                            Total   Percent      Mean/Cat
3. Correct Responses:         58        45.31    19.333
4. Total Errors:              70        54.68    23.333
5. Perseverative Responses    72        56.25    36
6. Perseverative Errors       49        38.28    24.5
7. Non-Perseverative Errors   21        16.4     7
8. Unique Errors              0         0        0
                        ---------------------------
8. Trials to complete 1st cat:   40
9. Failure to maintain set:      NOT COMPUTED
10. Learning to Learn:           NOT COMPUTED
11. Conceptual Level responses:  NOT COMPUTED
12. Perseverative Runs: Min    Max   Mean   Total
                         5      25     15   30
---------------------------------------------------
```

Figure 11: Summary Report of the BCST

The final demographic variables of interest were: Participant ID, Branch (1 = Khomelela, 2 = Hyde Park), Gender (1 = Male, 2 = Female), Age, Time Since Injury in Months, Length of Coma, and Duration of PTA. The independent variables were: Total SES score, Race (1 = Asian, 2 = Black, 3 = Coloured, 4 = White), Level of Education (subsequently dichotomised into Matric and tertiary versus less than Matric), Quality of Education (Private/Model C versus DET or former DET schooling), and Access to Medical Aid (1 = no, 2 = yes). Finally, the dependent variables of interest were: Stroop Response Time, TTT *np* score, TTT *comp* score, IGT Final Amount (2000 + reward – penalty), BCST Categories Completed, BCST Correct Responses, BCST Total Errors, BCST Perseverative Responses, BCST Perseverative Errors, BCST Non-Perseverative Errors, BCST Trials to Complete First Category, and BCST Perseverative Runs.

## Threats to Validity

The greatest threat to validity in this study was the small sample size. Because a particular population was identified for this study (high-functioning attendees at Headway Hyde Park and Khomelela) the pool of participants was finite and thus it was not possible to increase the sample size. It was initially planned to match participants on such variables as time elapsed since injury, length of coma, duration of PTA, and level of education, but the small sample made such matching meaningless. Sample size also affected the types of analyses that could be carried out, making it necessary to dichotomise variables such as level of education. Finally, using such a small and specific sample affected the external validity and generalisability of the results of the study.

## Data Analysis

The SES Questionnaire data and the scores from the TTT were captured on separate Microsoft Excel spreadsheets. Both spreadsheets were uploaded into SAS Enterprise Guide Version 4.2 (SAS; "SAS Enterprise Guide," 2008) as separate projects. A short program was written to upload the text files produced by the Stroop, IGT and BCST into SAS. Only the IGT application automatically encoded the participant number in the text file, so the text files for the Stroop and the BCST were manually manipulated to change the Participant ID from the default of "0" to the appropriate Participant ID code before they were uploaded into SAS. The Report Summary text file from the BCST was captured on a Microsoft Excel spreadsheet and then uploaded into SAS. All statistical analyses were carried out using the SAS Enterprise Guide Version 4.2 statistical software.

The SES Questionnaire was summarised and the following variables were copied into a new spreadsheet that contained the following fields: Participant ID, Branch, Gender, Race, Age, Quality of Education, Level of Education, Time Since Injury, Length of Coma, Duration of PTA, Access to Medical Aid, and Total SES (calculated as the sum of the scores for Quality of Education, Level of Education and Access to Medical Aid from Section A, and all items from Section B of the Questionnaire). Level of Education was split into two variables: 11 years or less of schooling (up to Grade 11; value of 1) and 12 years or more (Matric/Grade 12 plus years of tertiary education; value of 2).

Each different dataset (Stroop, IGT and BCST) was uploaded as a separate project in SAS, and descriptive statistics were run across each dataset. The mean Response Time per participant on the Stroop was determined and then divided by 1000 to give the Response Time in seconds. The total Reward and Penalty Amounts on the IGT were calculated for each participant. The following summary report variables from the BCST were extracted: Total Correct Responses, Total Errors, Total Perseverative Responses, Total Perseverative Errors, Total Non-Perseverative Errors, Trials to Complete First Category and Total Perseverative Runs. A new, composite Excel spreadsheet was then created by manually capturing all of the aforementioned dependent variables and adding them to the SES summarised data. This was then uploaded into SAS as a new, separate dataset.

With regard to the BCST data, if a participant does not complete the first category before the end of the test (128 trials) the PEBL software defaults 0 in the following fields of the BCST summary report: Total Perseverative Responses, Total Perseverative Errors, and Trials to Complete First Category. However, according to the WCST Manual, if the first category is not completed, “the client receives a Trials to Complete First Category raw score of 129” (Heaton, et al., 1993, p. 12). Therefore in the instance of the four participants who did not complete the first category the 0 was manually changed to 129. The other two results are logically correct as perseverative responses and errors are only made once a category has been completed and the participant incorrectly applies the rule of the completed category to the current category.

A correlation between the Total SES score and Stroop Mean Response Time was conducted to ascertain whether SES had an effect on the participant’s computer response time. Thereafter the dependent variables (TTT *np* Score, TTT *comp* Score, IGT Final Balance, BCST Total Correct Responses, BCST Total Errors, BCST Total Perseverative Responses, BCST Total Perseverative Errors, BCST Total Non-Perseverative Errors, BCST Trials to Complete First Category, and BCST Total Perseverative Runs) were correlated with total SES. The aim of this analysis was to ascertain if differences in SES had a significant relationship with any of the dependent variables.

A subsequent series of analyses using *t*-tests or ANOVA (where appropriate) was conducted using the abovementioned dependent variables and the following discrete components of SES as independent variables: Race, Level of Education (dichotomised), Quality of Education and Access to Medical Aid.

## Ethics

All participants were required to sign an informed consent form (Appendix B). The anonymity of the participants and confidentiality of their scores was maintained by allocating a code number to each participant and their corresponding data.

Due to the researcher’s position as a counsellor at Headway Gauteng, care was taken to be sensitive to the power differential between her and the attendees. For example, an attendee may have felt obliged to consent verbally to participating, but then would make excuses in order to avoid taking part. Such participants were excused. Similarly, any attendees had taken part in counselling with the researcher or had previously been neuropsychologically assessed by her were not explicitly invited to take part. However, if as a result of talking to other attendee participants or seeing the poster they spontaneously approached the researcher and volunteered to participate, they were accepted as participants.

# Results

## Composition of the Sample

The demographic profile of the sample of twenty-five individuals who participated in this study is summarised in Table 2 below.

Table 2:

*Demographic Profile of the Sample*

| Demographic Factor | Freq (*n*) | Percent | Mean (SD) | Range |
|---|---|---|---|---|
| ***Branch*** | | | | |
| Hyde Park | 15 | 60% | | |
| Khomelela | 10 | 40% | | |
| **Age** | 25 | | 43.68 (9.49) | 28.0 – 60.0 |
| **Gender** | | | | |
| Male | 20 | 80% | | |
| Female | 5 | 20% | | |
| **Race** | | | | |
| Black | 13 | 52% | | |
| Coloured | 2 | 8% | | |
| White | 10 | 40% | | |
| **Type of injury** | | | | |
| Stroke | 5 | 20% | | |
| Aneurysm | 2 | 8% | | |
| TBI | 18 | 72% | | |

Table 2 (continued):

*Demographic Profile of the Sample*

| Demographic Factor | Freq (*n*) | Percent | Mean (SD) | Range |
|---|---|---|---|---|
| **Length of Coma** | | | Data was not available for 7 participants | |
| Less than 1 hour | 5 | 27.78% | | |
| 1 to 12 hours | 1 | 5.56% | | |
| 12-24 hours | 0 | | | |
| 1 to 7 days | 1 | 5.56% | | |
| 7 to 30 days | 5 | 27.78% | | |
| 2 to 6 months | 6 | 33.33% | | |
| **Duration of PTA** | | | Data was not available for 8 participants | |
| Less than 1 hour | 3 | 17.65% | | |
| 1 to 12 hours | 1 | 5.88% | | |
| 12-24 hours | 1 | 5.88% | | |
| 1 to 7 days | 1 | 5.88% | | |
| 7 to 30 days | 3 | 17.65% | | |
| 2 to 6 months | 5 | 29.41% | | |
| More than 6 months | 3 | 17.65 | | |
| **Time since injury (months)** | 24 | | 103.04 (84.93) | 6.0 – 372.0 |
| **Glasgow Coma Scale (GCS)** | | | No data was available for participants | |
| **SES** | | | 52.24 (11.93) | 29.0 – 69.0 |
| **Type of education** | | | | |
| DET[1] | 11 | 44% | | |
| Model C[2] | 14 | 56% | | |

Table 2 (continued):

*Demographic Profile of the Sample*

| Demographic Factor | Freq (*n*) | Percent | Mean (SD) | Range |
|---|---|---|---|---|
| **Level of education (years)** | | | 13.56 (2.71) | 9.0 – 20.0 |
| **Level of education (category)** | | | | |
| Secondary (< Matric) | 5 | 20% | | |
| Tertiary (Matric and higher) | 20 | 80% | | |
| **Access to private healthcare** | | | | |
| No | 11 | 44% | | |
| Yes | 14 | 56% | | |

1. DET includes government schools in Zimbabwe (Shuttleworth-Edwards, 2010)
2. Model C includes South African and Zimbabwean private schools
3. Participants from Khomelela were selected from a list of individuals who had been identified as suitable candidates for a neuropsychological assessment. This list also contained information pertaining to attendees' multilingualism.

In the above table it is apparent that data pertaining to severity of injury such as Length of Coma and Duration of PTA were incomplete. There were no data available for the Glasgow Coma Scale at time of injury. Because of this it made it difficult to assess the severity of the injury.

## Computer Response Time

As two of the tasks (the IGT and the BCST) were computer-based, the response time on the Practice Run of the Stroop Test was used as a control variable to quantify the differences in computer response time between those participants who had had more exposure to computers (those from the higher SES group) and those who had had little or no computer experience (those with a lower SES). A correlation between Total SES and Stroop Response Time was not significant with $r = -0.35$, $p = 0.09$.

## Socioeconomic Status (SES)

A correlation was performed to determine if there was a relationship between the Total SES score and the dependent variables. The dependent variables of interest were: TTT *np* Score, TTT *comp* Score, IGT Final Balance, BCST Categories Completed, BCST Total Correct Responses, BCST Total Errors, BCST Perseverative Responses, BCST Perseverative Errors, BCST Non-Perseverative Errors, BCST Trials to Complete First Category, and BCST Perseverative Runs. The results of the correlation are summarised in Table 3.

Table 3:

*Correlations between Total SES and Dependent Variables*

| **Variable** | ***n*** | **Mean (SD)** | **Pearson's r** | **p** |
|---|---|---|---|---|
| TTT *np* score | 25 | 1.72 (0.89) | 0.48 | 0.01* |
| TTT *comp* score | 25 | 6.28 (1.74) | -0.11 | 0.62 |
| IGT final balance | 25 | 1762 (527.33) | -0.31 | 0.14 |
| BCST categories completed | 24[1] | 3.04 (2.33) | -0.33 | 0.12 |
| BCST correct responses | 24[1] | 74.96 (16.88) | -0.25 | 0.24 |
| BCST total errors | 24[1] | 53.04 (16.88) | 0.25 | 0.24 |
| BCST perseverative responses | 24[1] | 36.42 (23.47) | 0.02 | 0.91 |
| BCST perseverative errors | 24[1] | 19.83 (14.43) | 0.13 | 0.53 |
| BCST non-perseverative errors | 24[1] | 33.21 (25.04) | 0.09 | 0.67 |
| BCST trials to complete first category | 24[1] | 49.92 (41.96) | 0.32 | 0.13 |
| BCST perseverative runs | 24[1] | 9.83 (8.51) | -0.10 | 0.64 |

*Significant at $p < 0.05$

1. Only 24 observations on the BCST variables (versus 25 for the other variables) were available.

The only significant relationship that emerged was a moderate relationship between Total SES and the TTT *np* Score (the number of pieces used in the TTT), with $r = 0.48$, $p = 0.01$, $r^2 = 0.23$. The correlation between Total SES and the TTT *np* score was positive, which indicates that the higher the SES of the participant, the more pieces they will use in the TTT. Any variance in Total SES had a moderate influence on the TTT *np* score. Other than the number of pieces used on the TTT, there was no correlation between the Total SES score in this study and the dependent variables from the IGT and the BCST. The possible reasons for this are discussed on page 82.

As there was little support for the hypothesis that SES in general has an effect on actor-centred, emotion-based or veridical decision-making after brain injury, certain discrete components of Total SES were compared individually with the dependent variables using *t*-tests. As indicated in the literature review, markers of SES include race/ethnicity, level of education, quality of education and access to private healthcare. In this study the variables of interest were Race, Level of Education, Quality of Education and Access to Medical Aid[1] respectively. Years and quality of education are currently of great interest in research into neuropsychological tests in South Africa (for example, see Cavé & Grieve, 2009; Shuttleworth-Edwards, 2010; Shuttleworth-Edwards, Donnelly, Reid, & Radloff, 2004). Whether or not a person has access to medical aid at the time of injury will often differentiate between the quality of medical care one receives in South Africa. Those who have medical aid are more likely to enjoy high quality care within the private sector, whereas those without will receive the basic care that is afforded to them by the government sector (Baker, 2010; Coovadia, et al., 2009).

With the focus on each independent variable (Race, Level of Education, quality of Education and Access to Medical Aid), participant demographics shifted. Therefore, within each

[1] *In South Africa it is common for individuals from a higher SES or with regular employment at a certain level to have medical insurance, referred to as medical aid.*

section of the results for the independent variables below, the participant demographics have been presented for clarity.

### Race

The participant demographics by Race (Black and White) are presented below in Table 4.

Table 4:

*Demographic Profile of the Sample by Race*

| **Race** | ***Black*** | | | | ***White (including Coloured)*** | | | |
|---|---|---|---|---|---|---|---|---|
| **Demographic Factor** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** |
| **SES** | 13 | | 44.92 (11.20) | 29.0 – 61.0 | 12 | | 60.17 (6.48) | 46.0 – 69.0 |
| **Age** | 13 | | 38.92 (8.88) | 28.0 – 60.0 | 12 | | 48.83 (7.41) | 38.0 – 58.0 |
| **Gender** | | | | | | | | |
| Male | 12 | 92% | | | 8 | 67% | | |
| Female | 1 | 8% | | | 4 | 33% | | |
| **Type of education** | | | | | | | | |
| DET | 10 | 77% | | | 1* | 8% | | |
| Model C | 3 | 23% | | | 11 | 92% | | |
| **Coloured participants were included with White participants* | | | | | | | | |
| **Level of education (years)** | 13 | | 12.69 (2.69) | 9.0 – 18.0 | 12 | | 14.50 (2.50) | 12.0 – 20.0 |
| **Level of education (category)** | | | | | | | | |
| Secondary (< Matric) | 5 | 38% | | | 0 | 0% | | |
| Tertiary (Matric and higher) | 8 | 62% | | | 12 | 100% | | |
| **Access to private healthcare** | | | | | | | | |
| No | 9 | 69% | | | 2 | 17% | | |
| Yes | 4 | 31% | | | 10 | 83% | | |

A Levene's test was conducted to check for equality of variance before an analysis of variance (ANOVA) was conducted between the independent variable of Race (three levels: Black, White and Coloured) and each of the dependent variables. The variables BCST Non-Perseverative Errors and TTT *comp* score had unequal variances, therefore a non-parametric Kruskal-Wallace one-way ANOVA was carried out for these variables. A parametric one-way ANOVA was conducted for the remaining dependent variables. The Kruskal-Wallis ANOVA did not produce significant results for either BCST Non-Perseverative Errors ($H_2$ = 2.33, $p$ = 0.35) or for the TTT *comp* score ($H_2$ = 2.33, $p$ = 0.31). The results of the parametric ANOVA are presented in Table 5.

Table 5:

*Analysis of Variance (ANOVA) between Race and Dependent Variables*

| **Variable** | **DF** | **F** | **p** |
|---|---|---|---|
| TTT *np* score | 2,22 | 2.11 | 0.15 |
| TTT *comp* score* | | | 0.35* |
| IGT final balance | 2,22 | 0.60 | 0.56 |
| BCST categories completed | 2,21 | 0.07 | 0.93 |
| BCST correct responses | 2,21 | 1.65 | 0.22 |
| BCST total errors | 2,21 | 1.65 | 0.22 |
| BCST perseverative responses | 2,21 | 0.49 | 0.62 |
| BCST perseverative errors | 2,21 | 0.54 | 0.59 |
| BCST non-perseverative errors* | | | 0.31* |
| BCST trials to complete first category | 2,21 | 0.23 | 0.79 |
| BCST perseverative runs | 2,21 | 0.39 | 0.67 |

*Variances were unequal – see non-parametric Kruskal-Wallis statistic above

As there were no significant results between the socio-economic marker of Race and the dependent variables using ANOVA, it was decided to combine the Coloured and White groups.

Both Coloured participants were from the Hyde Park group, both had received tertiary education, and both were employed in high functioning occupations before they sustained a head injury. On these grounds it was decided that they fitted culturally and economically with the White group. This reduced the categories of the Race variable to two, and it was therefore appropriate to use a *t*-test. A Levene's Test for homogeneity of variance was conducted which showed that all the dependent variables had equal variance. The results of the *t*-test are in Table 6.

Table 6:

*Comparison of means between Race and Dependent Variables*

| **Variable** | **DF** | **t** | **p** |
|---|---|---|---|
| TTT *np* score | 23 | -2.09 | 0.05* |
| TTT *comp* score | 23 | -0.14 | 0.89 |
| IGT final balance | 23 | 1.12 | 0.27 |
| BCST categories completed | 22 | -0.09 | 0.93 |
| BCST correct responses | 22 | -1.13 | 0.27 |
| BCST total errors | 22 | 1.13 | 0.27 |
| BCST perseverative responses | 22 | -0.71 | 0.49 |
| BCST perseverative errors | 22 | -0.81 | 0.42 |
| BCST non-perseverative errors | 22 | 1.25 | 0.23 |
| BCST trials to complete first category | 22 | -0.35 | 0.73 |
| BCST perseverative runs | 22 | -0.71 | 0.48 |

*Significant at $p < .05$

The only result that bordered on significance was that of the TTT *np* score ($t_{23} = -2.09$, $p = 0.048$). The number of pieces used in the TTT is divided into four categories: Category 1 (less than 20 pieces), 2 (between 20 and 29 pieces), 3 (between 30 and 39 pieces), and 4 (between 40 and 50 pieces). Examination of the means between the Black and White groups revealed that the Black group had a mean of 1.38 (SD = 0.65) which indicates that this group used on average 29 or less pieces in their constructions whereas the White group (M = 2.08, SD = 1.00) used from 30 to 39 pieces of average. There was no significant result for Race with respect to the variables TTT *comp* score, IGT Final Balance, BCST Categories Completed, BCST Correct Responses, BCST Total Errors, BCST Perseverative Responses, BCST Perseverative Errors, BCST Non-Perseverative Errors, BCST Trials to Complete First Category, and BCST Perseverative Runs.

**Level of Education.**

The participant demographics by Level of Education (Secondary and Tertiary) are presented in Table 7 below:

Table 7:

*Demographic Profile of the Sample by Level of Education*

| **Level of education (category)** | ***Secondary (< Matric)*** | | | | ***Tertiary (Matric and higher)*** | | | |
|---|---|---|---|---|---|---|---|---|
| **Demographic Factor** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** |
| **SES** | 5 | | 37.40 (6.50) | 29.0 – 43.0 | 20 | | 55.95 (9.92) | 32.0 – 69.0 |
| **Age** | 5 | | 41.20 (10.85 ) | 32.0 – 60.0 | 20 | | 44.30 (9.33) | 28.0 – 58.0 |
| **Gender** | | | | | | | | |
| Male | 4 | 80% | | | 16 | 80% | | |
| Female | 1 | 20% | | | 4 | 20% | | |
| **Race** | | | | | | | | |
| Black | 5 | 100% | | | 8 | 40% | | |
| White | 0 | | | | 12 | 60% | | |
| **Type of education** | | | | | | | | |
| DET | 4 | 80% | | | 7 | 35% | | |
| Model C | 1 | 20% | | | 13 | 65% | | |

Table 7 (continued):

*Demographic Profile of the Sample by Level of Education*

| **Level of education (category)** | ***Secondary (< Matric)*** | | | | ***Tertiary (Matric and higher)*** | | | |
|---|---|---|---|---|---|---|---|---|
| **Demographic Factor** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** |
| **Level of education (years)** | 5 | | 10.20 (1.10) | 9.0 – 11.0 | 20 | | 14.40 (2.30) | 12.0 – 20.0 |
| **Access to private healthcare** | | | | | | | | |
| No | 5 | 100% | | | 6 | 30% | | |
| Yes | 0 | | | | 14 | 70% | | |

The interval-type variable Level of Education was dichotomised into two categories: 11 years or less of formal schooling (up to Grade 11) and 12 years or more schooling (Grade 12 plus years of tertiary education) as completing school is perceived as a marker of SES. A Levene's Test for homogeneity of variance was conducted which showed that all the dependent variables had equal variance. A *t*-test was carried out between the dichotomised Level of Education variable and the dependent variables: TTT *np* score, TTT *comp* score, IGT Final Balance, BCST Categories Completed, BCST Correct Responses, BCST Total Errors, BCST Perseverative Responses, BCST Perseverative Errors, BCST Non-Perseverative Errors, BCST Trials to Complete First Category, and BCST Perseverative Runs. The results of the *t*-tests are presented in Table 8.

The Levene's Test and the Folded F statistic indicated that all variances were equal, therefore the *t*-test Pooled statistic was used. The *t*-tests revealed that there were no significant results when comparing the means of the dependent variables between individuals who had Grade 12 and tertiary education versus those who had not achieved Grade 12. Thus in this sample there were no differences in decision-making in those with brain injury when taking level of education into account. The possible reasons for this are discussed on page 85.

Table 8:

*Comparison of Means between Years of Education1 and Dependent Variables*

| Variable | DF | t | p |
|---|---|---|---|
| TTT *np* score | 23 | -1.50 | 0.15 |
| TTT *comp* score | 23 | -0.68 | 0.51 |
| IGT final balance | 23 | 1.86 | 0.08 |
| BCST categories completed | 22 | 0.42 | 0.68 |
| BCST correct responses | 22 | -0.06 | 0.95 |
| BCST total errors | 22 | 0.06 | 0.95 |
| BCST perseverative responses | 22 | -1.35 | 0.19 |
| BCST perseverative errors | 22 | -1.67 | 0.11 |
| BCST non-perseverative errors | 22 | 0.96 | 0.35 |
| BCST trials to complete first category | 22 | -0.80 | 0.43 |
| BCST perseverative runs | 22 | -0.79 | 0.44 |

1. Years of Education was dichotomised into two categories: individuals who had not passed Grade 12 (up to 11 years), and individuals who had passed Grade 12 and had received some tertiary education (12 or more years).

**Quality of Education.**

The effect of Quality of Education on the dependent variables was next investigated. The participant demographics by Quality of Education (DET and Model C) are presented below in Table 9.

Participants who had been educated under the former Department of Education and Training (DET) were compared to those who had attended the formerly White Private/Model C-type schools. Those who were educated in Zimbabwe at government schools were placed in the DET category. Those who had attended private schools in Zimbabwe or in South Africa were placed in the Model C category (Shuttleworth-Edwards, 2010). One individual had been educated in Europe and was placed in the Model C category on the assumption that a European education would be at least at the same level as that of a South African Model C-type school.

Table 9:

*Demographic Profile of the Sample by Quality of Education*

| **Type of Education** | ***DET*** | | | | ***Model C*** | | | |
|---|---|---|---|---|---|---|---|---|
| **Demographic Factor** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** |
| **SES** | 11 | | 45.36 (12.56) | 29.0 – 61.0 | 14 | | 57.64 (8.36) | 40.0 – 69.0 |
| **Age** | 11 | | 41.09 (9.54) | 28.0 – 60.0 | 14 | | 45.71 (9.29) | 29.0 – 58.0 |
| **Gender** | | | | | | | | |
| Male | 9 | 82% | | | 11 | 79% | | |
| Female | 2 | 18% | | | 3 | 21% | | |
| **Race** | | | | | | | | |
| Black | 10 | 91% | | | 3 | 21% | | |
| White (including Coloureds) | 1 | 9% | | | 11 | 79% | | |
| **Level of education (years)** | 11 | | 12.27 (2.57) | 9.0 – 18.0 | 14 | | 14.57 (2.44) | 11.0 – 20.0 |
| **Level of education (category)** | | | | | | | | |
| Secondary (< Matric) | 4 | 36% | | | 1 | 7% | | |
| Tertiary (Matric and higher) | 7 | 64% | | | 13 | 93% | | |
| **Access to private healthcare** | | | | | | | | |
| No | 7 | 64% | | | 4 | 29% | | |
| Yes | 4 | 36% | | | 10 | 71% | | |

A Levene's Test for homogeneity of variance was conducted, and revealed that the variances of the following dependent variables were unequal: TTT *comp* Score, BCST Correct Responses, BCST Total Errors, and BCST Non-Perseverative Errors. In the *t*-tests the Satterthwaite statistic was used to ascertain significance for these variables. The results of the *t*-tests are presented in Table 10.

Table 10:

*Comparison of means between DET/ Model C Type of Education[1] and dependent variables*

| Variable | DF | t | p |
|---|---|---|---|
| TTT *np* score | 23 | -1.86 | 0.08 |
| TTT *comp* score[2] | 21.13 | -0.75 | 0.46 |
| IGT final amount | 23 | 0.91 | 0.37 |
| BCST categories completed | 22 | -0.96 | 0.35 |
| BCST correct responses[2] | 13.37 | -1.80 | 0.09 |
| BCST total errors[2] | 13.37 | 1.80 | 0.09 |
| BCST perseverative responses | 22 | -2.31 | 0.03* |
| BCST perseverative errors | 22 | -2.41 | 0.02* |
| BCST non-perseverative errors[2] | 10.82 | 2.53 | 0.03* |
| BCST trials to complete first category | 22 | 1.15 | 0.26 |
| BCST perseverative runs | 22 | -0.99 | 0.33 |

1. DET includes former DET schools in South Africa and government education in Zimbabwe. Model C includes former White government education in South Africa and private schools in South Africa and Zimbabwe
2. Unequal variance

Three variables were found to be significant: BCST Number of Perseverative Responses, BCST Perseverative Errors and BCST Non-Perseverative Errors. The number of BCST Perseverative Responses was significant with $t_{22} = -2.31$, $p = 0.03$ and an effect size of 0.96, which indicates that in this sample the quality of education had a large effect on the number of perseverative responses. Examination of the means reveals that those coming from a DET education background had an average of 24.40 perseverative responses, whereas former Model C pupils had a mean of 45.00 responses. As the Model C group had a greater number of perseverative responses than the DET group, a better quality of education resulted in significantly more perseverative responses. This result is appeared to be counter-intuitive but the reasons for this are discussed below.

The number of BCST Perseverative Errors was also significant, with $t_{22} = -2.41$, $p = 0.02$ and an effect size of 1.0, indicating that the quality of education in this sample had a large effect on number of perseverative errors. Examination of the means (DET: $M = 12.20$, Model C: $M = 25.29$) revealed that those who received a lower quality of education made fewer perseverative errors than those who received a better quality of education, which also appeared to be counter-intuitive.

The reason for the counter-intuitive results pertaining to the BCST Perseverative Responses and Perseverative Errors is that the numbers of perseverative responses and errors are dependent upon the number of categories correctly completed, that is the more categories completed, the higher the number of perseverative errors and responses (Axelrod, 2010, personal communication). On the other hand, the number of non-perseverative errors made is independent of the number of categories correctly completed because all participants completed 128 trials of the BCST.

In order to illustrate the counter-intuitive results for numbers of perseverative errors and responses, the means for BCST Categories Completed and BCST Categories Experienced were compared by Type of Education. The results are presented in Table 11. Comparison of the means revealed that the average number of BCST Categories Completed was lower for those with a poorer quality of education compared to those with a better quality of education. Individuals who had received a Model C-type education completed more categories in the BCST than those who had received a DET education. In order to confirm this, frequency counts for number of BCST trials to complete first category were conducted for both groups. If the first category was not completed by the end of the test (128 trials), this variable is allocated a value of 129. The results showed that 4 out of 10 participants in the DET group did not complete the first category by the end of the test (129 trials), whereas only 1 participant out of 14 did not complete the first BCST category in the Model C Group (see Figures 4.1 and 4.2 below). If the first category had not been correctly completed by the end of the test, it follows that there would not be any perseverative errors or responses made as there would be no previous category to elicit perseverative behaviour. Thus it makes sense that the number of perseverative errors and responses for the better-educated group would be higher than the group with the poorer quality of education.

Table 11:

*Means of BCST categories completed by Quality of Education*

| **Variable** | ***n*** | **M (SD)** | **Range** |
|---|---|---|---|
| DET education[1] | | | |
| Categories completed | 11 | 2.50 (2.46) | 0 – 7 |
| Model C education[2] | | | |
| Categories completed | 14 | 3.43 (2.24) | 0 – 7 |

1. DET includes former DET schools in South Africa and government education in Zimbabwe.
2. Model C includes former White government education in South Africa and private schools in South Africa and Zimbabwe

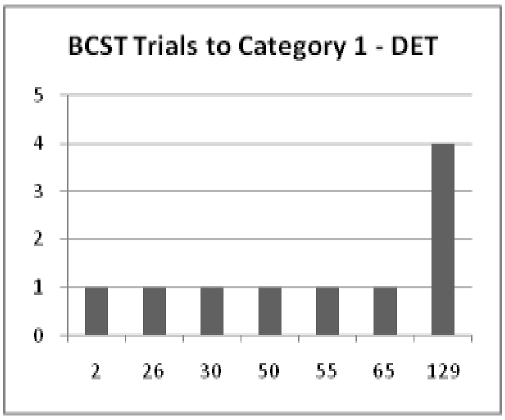


Figure 12: BCST Trials To Complete First Category for the DET Group

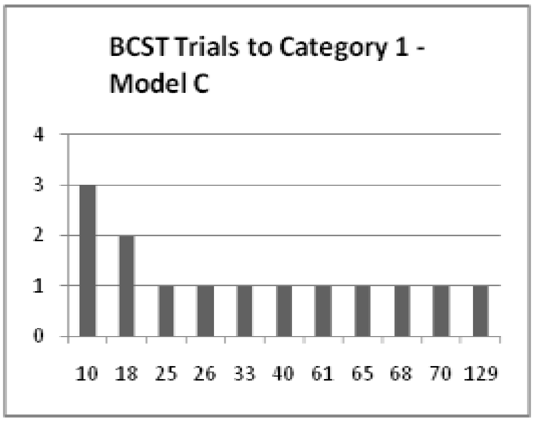


Figure 13: BCST Trials to Complete First Category for the Model C Group

The results for BCST Non-Perseverative Errors (which had unequal variances) were $t_{10.82}$ = 2.53, $p$ = 0.0285 with an effect size of 1.19. Perusal of the respective means showed that participants from the DET category (*M* = 48.40, SD = 31.08) made more non-perseverative errors than those from the Model C category (*M* = 22.36, SD = 11.65), which suggests that those with a poorer quality of education made more non-perseverative errors than those with a better quality of education.

**Quality of Medical Care.**

The participant demographics by Quality of Education (DET and Model C) are presented below in Table 12.

The type of medical care (private versus government) received by participants was ascertained by asking whether they had been covered by a medical aid at the time of the injury, or if they had been taken to and remained at a private hospital or clinic. Some participants did not have medical aid, but were covered by the Workmen's Compensation Act (WCA) and were thus afforded treatment at a private hospital.

A Levene's Test for homogeneity of variance and the Folded F statistic revealed that the variable BCST Trials to Complete First Category did not have equal variance, therefore the *t*-test

Satterthwaite statistic was used to ascertain significance for this variable. The results are summarised in Table 13.

Table 12:

*Demographic Profile of the Sample by Quality of Medical Care*

| **Access to Medical Aid/WCA** | ***No*** | | | | ***Yes*** | | | |
|---|---|---|---|---|---|---|---|---|
| **Demographic Factor** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** | **Freq (*n*)** | **%** | **Mean (SD)** | **Range** |
| **SES** | 11 | | 42.36 (10.59) | 29.0 – 62.0 | 14 | | 60.0 (5.41) | 50.0 – 69.0 |
| **Age** | 11 | | 41.36 (8.70) | 29.0 – 60.0 | 14 | | 45.50 (10.01) | 28.0 – 58 .0 |
| **Gender** | | | | | | | | |
| Male | 10 | 91% | | | 10 | 71% | | |
| Female | 1 | 9% | | | 4 | 29% | | |
| **Race** | | | | | | | | |
| Black | 9 | 82% | | | 4 | 29% | | |
| White | 2 | 18% | | | 10 | 71% | | |
| **Type of education** | | | | | | | | |
| DET | 7 | 64% | | | 4 | 29% | | |
| Model C | 4 | 36% | | | 10 | 71% | | |
| **Level of education (years)** | 11 | | 12.27 (2.45) | 9.0 – 17.0 | 14 | | 14.57 (2.53) | 12.0 – 20.0 |
| **Level of education (category)** | | | | | | | | |
| Secondary (< Matric) | 5 | 45% | | | 0 | | | |
| Tertiary (Matric and higher) | 6 | 55% | | | 14 | 100% | | |

There were no significant results in the comparison between quality of medical care at injury and the dependent variables. The possible reasons for this are discussed on page 88.

Table 13:

*Comparison of Means between Quality of Medical Care and Dependent Variables*

| Variable | DF | t | p |
|---|---|---|---|
| TTT *np* score | 23 | -1.34 | 0.19 |
| TTT *comp* score | 23 | 0.21 | 0.84 |
| IGT final amount | 23 | 1.95 | 0.06 |
| BCST categories completed | 22 | 0.63 | 0.54 |
| BCST correct responses | 22 | 1.20 | 0.24 |
| BCST total errors | 22 | -1.20 | 0.24 |
| BCST perseverative responses | 22 | 0.33 | 0.75 |
| BCST perseverative errors | 22 | 0.07 | 0.94 |
| BCST non-perseverative errors | 22 | -0.84 | 0.41 |
| BCST trials to complete first category[1] | 19.63 | -1.69 | 0.11 |
| BCST perseverative runs | 22 | -0.21 | 0.84 |

1. Unequal variance

## Summary of Results

The correlation between Total SES and Stroop Response Time revealed that there was no significant relationship between SES and response time on the computer. This indicates that computer response time was not a confounding variable despite the tendency for individuals from a lower SES to have less access to computers. A correlation was then conducted between the Total SES scores and the dependent variables. The only significant relationship that emerged was a moderate one between Total SES and the number of pieces used on the TTT (*np*).

As there were no significant relationships between Total SES and the remaining dependent variables, certain discrete markers of SES were compared to performance on the instruments measuring decision-making. These variables were Race, Level of Education, Quality of Education and Access to Medical Aid.

An ANOVA was conducted to compare differences in decision-making among the three different races, namely Black, White and Coloured. As there were no significant results, the Coloured group (n = 2) was included in the White group, resulting in only two Race groups, Black and White. A *t*-test revealed that there were no significant differences in decision-making in brain injured individuals between the two Race groups.

In this sample there were no significant differences in decision-making in those with brain injury when taking Level of Education (Grade 11 and less versus Grade 12 and tertiary education) into account. However, with regard to Quality of Education three variables were significant: BCST Perseverative Responses, BCST Perseverative Errors and BCST Non-Perseverative Errors. There were higher numbers of perseverative errors and responses in those with a better quality of education which was an artefact of the higher number of completed categories on the BCST by those with a superior education. The results for BCST perseverative responses indicate that in this sample the quality of education received had a large effect on number of perseverative responses; that is, a better quality of education showed significantly more perseverative responses (due to the higher number of categories completed). The quality of education in this sample also had a large effect on number of perseverative errors made. Those with a lower quality of education made fewer perseverative errors than those who received a better quality of education. However, those with a lower quality of education made more non-perseverative errors than those with a better quality of education. This result is interesting as it replicates other South African studies that have shown a relationship with discrepancies in neuropsychological psychometric test results and inequalities in quality of education.

Finally, there were no significant differences between groups when comparing the means of the dependent variables between those who had had access to private medical care versus those participants who had received government or non-private medical care at the time of injury.

# Discussion

The principal aim of this study was to investigate differences in performance on decision-making between individuals from different socio-economic strata who had sustained an acquired brain injury (ABI). Three types of decision-making were investigated: actor-centred, emotion-based and veridical decision-making. Actor-centred decisions relate to the individual and the current context, and the outcome of the decision is correct for the person at that time (Goldberg, 2009; Goldberg, et al., 1994). Emotion-based decision-making is rooted in physiological sensations or somatic markers that can be loosely interpreted as 'gut feelings' which indicate to the individual whether the anticipated outcome of their decision is 'good' or 'bad' (Bechara, 2004; Damasio, et al., 1991; Turnbull, et al., 2003; Turnbull, et al., 2005). Typically, both actor-centred and emotion-based decision-making take place in ambiguous situations. Veridical decision-making is unambiguous and is about the 'truth': there is a right or wrong answer to the question posed by the individual's current situation (Goldberg, 2009). In order to make an appropriate decision within a certain context and to act upon it, a person needs to form a goal-oriented strategy and then to follow through on the chosen plan of action.

The above types of decision-making are all required at one time or another to set a goal, to plan and then to follow through to attain the goal. Planning, goal-setting, set shifting and motivating oneself to achieve that goal are part of the executive functions orchestrated by the frontal lobes of the human brain (Alvarez & Emory, 2006). However, executive functions such as goal-setting and decision-making require an intact brain. There is a prolific amount of research which has shown that people who have sustained an ABI either as a result of a medical condition or of trauma, have impaired executive and decision-making functions (Bayless, et al., 1989; Bechara, 2004; Blake, Fichtenberg, & Abeare, 2009). A number of factors can affect recovery and outcomes after ABI.

One particular area of research into recovery after ABI is that of *cognitive reserve* (CR). The concept of cognitive reserve is that a larger brain (measured by total intracranial volume), belonging to an individual with a higher IQ and better education, will be more resilient to injury or illness (Basso & Bornstein, 2000; Kesler, et al., 2003; Starr & Lonie, 2008). The hypothetical construct of *brain reserve capacity* (BRC) was first posited by Satz (1997) based on the physiological perspective of cerebral size. BRC was later expanded into the CR hypothesis (Stern, 2002) which maintained that the neural networks used by a brain-healthy person when performing at maximum capacity are less susceptible to disruption in the event of illness or injury. It was further hypothesised that the more distributed or widespread these neural networks are, the better chance there is of 'buffering' in the event of brain damage (Stern, 2002). According to the CR hypothesis the number of distributed neural networks in the brain can be enhanced by higher intellect and a higher level of education, it therefore follows that persons from a lower SES who have received a fewer years and a poorer quality of education as well as less than optimum nutrition and medical care would not have the advantageous buffering effect of SES on brain injury.

It is understandable then, that a second focus of research into ABI is the impact of SES on recovery. A number of studies have concluded that individuals from lower socio-economic strata have lower functional outcomes when compared to those who are financially better off (for example, see Arango-Lasprilla, et al., 2007; Gary, et al., 2010). The quality of medical care received at the time of injury can affect functional outcomes (Arango-Lasprilla, et al., 2007; Gary, et al., 2010). Previous research has also revealed that there is a relationship between SES and differences in test outcomes in persons with or without brain injury. For example, research into performance on neuropsychological tests has highlighted markers of SES that affect test results in persons without brain injury, such as the level of education (Evans, et al., 2004; Fry, et al., 2009; Rosselli & Ardila, 2003), and quality of education (Cavé, 2008; Shuttleworth-Edwards, 2010; Shuttleworth-Edwards, Kemp, et al., 2004; Walker, Batchelor, & Shores, 2009).

For the current study it was hypothesised that in persons with ABI the differences in executive function and decision-making impairments would be exacerbated in relation to differences in SES. The aim of the current study was to investigate whether there would be differences in performance on neuropsychological tests in persons with brain injury, with the general focus on disparities in SES, and specific focus on Race, Level of Education, Quality of Education and Quality of Medical Care. It was assumed that those with higher SES would exhibit superior performance on neuropsychological tests of decision making thanks to the buffering effect of a higher SES.

It was anticipated that by using tests of decision-making to investigate the abovementioned variables in a brain injured sample, differences in the executive functions required for successful decision-making (goal setting, planning, set-shifting and follow-through) would be apparent between individuals of different SES. The aim of the study was operationalised by using the following neuropsychological tests of executive function and decision-making: the TTT (actor-centred decision-making), the IGT (emotion-based decision-making) and the WCST (veridical decision-making). The sample for this study was purposively selected from attendees at Headway Gauteng (Headway), an organisation for people with ABI. At the time of research, Headway had two branches: Hyde Park (where the average SES is higher and only some of the attendees are sponsored) and Khomelela in Alexandra, where the average SES is low and all attendees are sponsored. Participants were asked to complete a questionnaire to gather demographic details and socio-economic status data. The Practice Round of the Stroop Test was administered to control for computer response time and levels of computer literacy between the different groups. The TTT was administered as per Lezak's (2004) instructions. Both the IGT and BCST (the computerised version of the WCST) were elements of the PEBL Neuropsychological Test Battery (Mueller, 2010).

## Computer Response Time

The Practice Round of the computerised version of the Stroop Test from the freeware PEBL Test Battery (Mueller, 2010) was used to record the Response Time for each participant, with the aim of ascertaining if there was a relationship between mean computer response time and SES. This variable was intended to control for possible differences in exposure to computers between those persons with a higher SES and those with lower SES. The result of the correlation between the total SES score and response time on the Stroop Practice Round was not significant, indicating that there was no relationship between the Total SES score of participants and computer response time. The initial assumption appeared to be correct: access to computers at Headway had helped to familiarise Khomelela participants to computer use.

## Socioeconomic Status

A series of correlations was performed to investigate the relationship between the Total SES score and the dependent variables. Only one of the dependent variables showed a significant relationship to the Total SES score: the number of pieces used on the TTT (*np* score). According to Lezak and colleagues (2004), participants who use relatively fewer pieces but are still are able to make recognisable and appropriately named constructions may have difficulty with initiation or completion of purposeful activities. As the TTT was a test of actor-centred decision-making, this indicated that there was a relationship between SES and actor-centred decision-making in the current sample. However, there was no relationship between SES and either emotion-based or veridical decision-making.

The possible reasons for this result are twofold. Firstly, it is feasible that persons from a lower SES do not have the buffering effect of SES on brain injury. As stated by the CR hypothesis, the number of distributed neural networks in the brain can be enhanced by higher intellect and level of education. It is argued that quality of education also plays a part here: if an individual is encouraged to study more widely and independently rather than learning facts by rote, it stands to reason that the individual will develop more diverse neural networks. Level and quality of education are markers for low SES in South Africa (Shuttleworth-Edwards, Kemp, et al., 2004). Secondly, although this result may indicate that brain-injured individuals from a lower SES background have greater impairment with regard to executive functions (goal setting, planning and attaining that goal) in an actor-centred context, it is also conceivable that they were not exposed to construction toys of any type or form in childhood. Thus the concept behind a test such as the TTT would be less familiar to a person from a low SES background than to one from a higher SES background. The issue of 'test-wiseness', or familiarity with tests and test materials has been discussed in previous studies (Kennepohl, et al., 2004; Nell, 2000; Walker, et al., 2010) and may be the reason for this particular result.

The components of SES into separate variables in order to examine the individual effects each may have on the outcomes of decision-making in individuals with brain injury from different SES. For the purposes of the current study, the elements used to differentiate between high and low SES were Race, Level of Education, Quality of Education and Quality of Medical Care.

**Race.**

A number of studies into the consequences of brain injury have examined differences in race or ethnicity and how such differences can affect post-injury outcomes. The majority of research studies that focus on SES and outcomes of brain injury associate low SES with minority groups who are not of European descent. Typically poorer outcomes are found for victims of ABI from low SES, ethnic minority populations in the US compared to those for Whites even after accounting for severity of injury and sociodemographic characteristics. For example, one US study found that on discharge and at one year follow-up after TBI, 'minority' groups (African Americans and Hispanics) compared unfavourably with Whites on functional outcomes such as disability, independence and integration into the community (Arango-Lasprilla, et al., 2007).

It is argued that the differences in outcomes between persons of different race or ethnicity can be extrapolated to the post-1994 situation in South Africa (after establishment of democratic rule). Studies have found that the majority of South Africans who are black and poor still receive a less than adequate education (Kahn, 2004) and only the most basic medical care (Baker, 2010; Coovadia, et al., 2009). Because of this, it was decided to use Race as a marker of SES in the current study.

Three Race groups were identified in this sample: Black ($n$ = 13), White ($n$ = 10) and Coloured ($n$ = 2). The result of an ANOVA comparing the means of each group with the dependent variables was inconclusive and it was decided to combine the Coloured group and the White group. A subsequent set of $t$-tests showed that between the two Race groups, only the TTT *np* score (the number of pieces used in constructions in the TTT) was significant.

The first hypothesis was therefore only partially confirmed, as this result indicates that there was no difference between the groups on tests of emotion-based or veridical decision-making. It also indicates that participants from an African culture performed less well on a test of actor-centred decision-making after sustaining an ABI. The reason for this could be that coming from a collectivistic culture, Black South Africans are not socialised as individuals but rather as an element in a harmonious whole (Wanasika, Howell, Littrell, & Dorfman, 2011). They would possibly find the actor-centred context less familiar than would a person from a more individualistic culture.

The argument made above also holds here: firstly, the possibility that South African Blacks who are predominantly from a lower SES when compared to Whites do not have the buffering effect of SES on brain injury.. Secondly, because of the abovementioned past and current discrepancies in South African education Black participants may have been less familiar with the concept of a construction set as well as with the testing situation.

**Level of Education.**

The interval-type variable Level of Education was dichotomised into two categories: Grade 11 and less ($n$ = 5), and Grade 12 and greater (including Tertiary education, $n$ = 20). From an educational perspective, individuals who attain Grade 12 (Matric) are generally considered to be superior to those who do not. $T$-tests were conducted between the categorical variable Level of Education and the dependent variables: TTT *np* and *comp* Scores, IGT Final Balance, BCST Categories Completed, BCST Total Correct Responses, BCST Total Errors, BCST Perseverative Responses, BCST Perseverative Errors, BCST Non-Perseverative Errors, BCST

Trials to Complete First Category, and BCST Perseverative Runs. There were no significant results for the comparison of means between the two categories and the dependent variables. This implies that in this particular sample level of education received did not have an effect on actor-centred, emotion-based or veridical decision-making. Therefore the second hypothesis was not confirmed, that is there was no difference in decision-making in persons with a brain injury with regard to the level of education.

With regard to emotion-based decision-making, this result contradicts the findings of an earlier South African study which found that brain-intact individuals with higher levels of education tended to perform significantly more poorly on the IGT (Evans, et al., 2004; Fry, et al., 2009). However, there is a possibility that in this sample the effect of the brain injury itself may have masked differences in decision-making performance due to level of education which could otherwise have been apparent.

**Quality of Education.**

The effect of quality of education on the results of neuropsychological tests has generated both interest and research in South Africa in recent years (Cavé & Grieve, 2009; Shuttleworth-Edwards, Kemp, et al., 2004). Participants in the current study who had been educated under the former Department of Education and Training (DET) or educated in Zimbabwe at government schools were placed in the DET category. Those who had attended the formerly White Private/Model C-type schools in South Africa or in Zimbabwe were placed in the Model C category (Shuttleworth-Edwards, 2010). One participant had been educated in Europe and was placed in the Model C category. The results of the *t*-tests showed that three variables were significant. Firstly, the number of BCST Perseverative Responses was significant indicating that in this sample the quality of education had a large effect on the number of perseverative responses. The Model C group had a greater number of perseverative responses than the DET group; therefore a better quality of education resulted in significantly more perseverative responses. Secondly, the number of BCST Perseverative Errors was also significant. Here again, the variable Quality of Education in this sample had an effect on the number of perseverative errors made. That is, those who received a better quality of education made a greater number of perseverative errors than those with a poorer quality of education. Finally, with regard to the variable BCST Non-Perseverative Errors the results indicated that participants from the DET category made more non-perseverative errors than those from the Model C category.

At first glance, the first two results appear to contradict the third, especially if we take into account that individuals from the Model C group would in all likelihood be more 'test-wise' than those from the DET group. In order to clarify this result, the means of the BCST Categories Completed were compared between the two groups. The Model C group completed 3.43 categories on average, whereas the DET group completed an average of 2.50 categories of the BCST. A frequency count for the variable BCST Trials to Complete First Category revealed that a greater proportion of participants from the DET group (40%) did not complete the first category, whereas only one participant from the Model C group failed to complete the first BCST category. As perseverative responses and errors are only computed once a person has completed the first BCST category, it makes sense that the DET group would have achieved lower scores on BCST Perseverative Responses and BCST Perseverative Errors (Axelrod, 2010). The reason for this could be attributed to an inability to learn the rule in those who had received an inferior education. Alternatively, it could again be as a result of the lack of test-wiseness on the part of those who did not have much exposure to psychometric tests during their years at school.

With regard to the third significant variable, BCST Non-Perseverative Errors, the results indicated that participants from the DET category made more non-perseverative errors than those from the Model C category. Therefore in this sample, those with a poorer quality of education made more non-perseverative errors than those with a better quality of education. The third hypothesis was therefore partially confirmed: individuals with ABI showed differences in veridical decision-making as a result of quality of education, but there was no difference in actor-centred or emotion-based decision-making.

These results concur with those found by Cavé and Grieve (2009) and Shuttleworth-Edwards and colleagues (2004). Cavé and Grieve used the WCST among other tests of executive function in a brain-intact sample of Grade 11 and Grade 12 learners from private and previously disadvantaged (DET) schools. They found that quality of education affected the participants' performance, with the private school learners performing significantly better than the learners from previously disadvantaged schools on all the tests of executive function. The study by Shuttleworth-Edwards and colleagues (2004) examined cross-cultural effects on IQ performance using the Wechsler Adult Intelligence Scale (WAIS-III). Participants from previous DET schools performed more poorly than those from Private/Model C schools in the Black/African first language group. Scores were significantly lower for participants who had received poor quality former DET education compared to good quality Private/Model C education (Shuttleworth-Edwards, Kemp, et al., 2004).

**Quality of Medical Care.**

Research has indicated that quality of medical care at the time of brain injury can have an impact on recovery. In South Africa, SES can influence the quality of medical care received by persons before and at the time of injury. Those from a low SES background who cannot afford medical aid (medical insurance) attend government hospitals and clinics which tend to be overcrowded and understaffed, resulting in a lower level of care in comparison to private clinics and doctors in private practice (Baker, 2010; Coovadia, et al., 2009). In contrast, if the injured person comes from a high SES background they are more likely to have medical aid and to be able to afford private medical care at the time of injury (Baker, 2010). The participants in the current study were therefore grouped according to whether or not they had had access to a medical aid at the time of their injury and *t*-tests were conducted to compare the means of the two groups on all dependent variables. None of the results were significant which indicated that in this particular sample the quality of medical care received at the time of injury had no effect on actor-centred, emotion-based or veridical decision-making. The fourth hypothesis was therefore not confirmed.

This finding contradicts a review of research undertaken in the United States in which differences in post-ABI outcomes as a result of disparities in the quality of medical care were found at the time of brain injury between ethnic groups. African Americans and Hispanics had worse functional outcomes and community integration and were less likely to receive treatment and be employed than Whites post-TBI (Gary, et al., 2010). A study by Arango-Lasprilla and colleagues (2007) also found that minorities (African-Americans and Hispanics) had significantly lower long-term functional outcomes after rehabilitation when compared to Whites. However, the aforementioned research did not conduct neuropsychological testing. With respect to functional and social outcomes as well as employment prospects after ABI, it is highly conceivable that Black South Africans would fare worse than White South Africans. As the current study found no evidence that differences in the quality of medical care have an effect on tests of decision-making in particular, it is possible either that the sample was not large enough to show results, or that decision-making as an executive function is too specific to differentiate between private and government medical care with regard to functional outcomes. It is also a possibility that South African Blacks may have achieved a degree of resilience after many years of legalised oppression under colonialism and apartheid. For example, in a study of six-year-old South African children by Barbarin and Richter (1999), it was found that across the socioeconomic spectrum children who lived in moderately safe neighbourhoods functioned better both socially and academically than those who came from safer areas (Barbarin & Richter, 1999).

## Limitations of the Current Study

Despite the useful finding in this study that quality of education has some effect on decision-making in those with brain injury, there are some flaws that may mitigate this finding.

The first and most obvious limitation is that of sample size. The small sample prevented any matching with regard to location of injury, time since injury, length of coma, duration of PTA, age, gender or level of education. It is possible that the results could have been confounded by not being able to control for these variables. Due to lack of matching of the abovementioned variables, it may be that there was in fact a difference in computer literacy between the high and low SES groups despite there being no relationship between SES and response time on the Stroop Practice Round that was used as an indicator of computer literacy and familiarity. This in turn would have had an impact upon all computerised test results.

Secondly, it was difficult to find accurate information on the severity of ABI for all the participants. Although access to the participants' Headway files was granted, the information contained therein was at times sketchy and in some cases, absent. It is accepted that variances in the severity of ABI within the participants could also affect the validity of results.

Thirdly, it is also possible that because this sample is particularly unique to Headway, the results are not generalisable. However, the finding that quality of education had a significant impact on measures of decision-making does suggest that further investigation into decision-making and executive function in individuals with brain injury who have received a different quality of education is called for. It is also argued that despite the size and specificity of current sample it is typically representative of victims of ABI in the South African context. Many victims of ABI from a low SES are Black, have had an inferior education and receive the minimum of medical care. Those from a higher SES are typically White, have had more years and a better quality of education, and generally receive a higher quality of medical care.

## Future Research Directions

The finding that quality of education had a significant impact on measures of executive function after ABI opens up the avenue for further studies of executive function in individuals with brain injury who have received a disparate quality of education. Future studies would need to match the participants in the quality of education conditions by injury site and severity, time since injury, length of coma, duration of PTA, age, gender and level of education.

## Conclusion

The current study represents an initial exploratory investigation into the effect of SES on decision-making as a marker of executive function after brain injury. The study found that premorbid quality of education had an effect on veridical decision-making after an ABI. As veridical decision-making is used in contexts where the outcome is either right or wrong, and involves cognitive set-shifting, it is conceivable that deficits in this area can contribute to poor decisions and poorer quality of life after brain injury in those who have received a poorer quality of education. Although the results suggest that quality of education had an effect on certain aspects of executive function and on veridical decision-making after brain injury, a great deal more research needs to take place with a larger sample and matching groups to exclude any confounding factors.

Brain injury as a result of illness or trauma will continue to claim victims in South Africa. However, it is sincerely hoped that results and conclusions from future studies on the disparities in quality of education and quality of acute and post-acute medical care in victims of ABI will have an effect on policy-makers' decisions in these areas, so that there will be reduced long-term disability and improved functionality in South African persons with brain injury.

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**APPENDIX A: Permission from Headway Gauteng to conduct the Study**

# Appendices

## APPENDIX A: Participant Information Sheet

**Participant Information Sheet**

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

School of Human and Community Development
*Private Bag, 3, Wits 2050, Johannesburg, South Africa*
*Tel: (011) 717-4500 Fax: (011) 717-4599*

Good Day,

My name is Christine Buchanan and I am conducting research for the purposes of obtaining a Masters Degree in the Discipline of Research Psychology at the University of the Witwatersrand. The aim of my research is to explore decision-making styles in individuals with acquired brain injury from different economic backgrounds. Although we live in the new democratic South Africa, research has shown that there are differences in the quality of education depending upon where you live and what you earn. It has also shown that recovery from brain injury can in part be influenced by the amount and quality of education a person has received pre-injury. I intend to investigate how people from different economic backgrounds differ in three decision-making styles: decisions with a right or wrong answer, decisions made on gut feel, and decisions made according to what is right for the person. The research is being conducted under the supervision of Professor Marilyn Lucas. We would like to invite you to participate in this study.

Participation in this research will involve doing three assessment tasks, at Headway Hyde Park or Headway's Alexandra (Khomelela) premises. The first task is a card-sorting task, the second is a computer card game and the third is a construction task. You will also be required to complete a questionnaire with questions about your age, sex, type of injury, time since injury, handedness, your education level and the type of school you attended. The second part of the questionnaire is designed to assess your standard of living.

## APPENDIX A: Permission from Headway Gauteng to conduct the Study

The assessment will last for approximately one hour. Participation is voluntary, and you will not be advantaged or disadvantaged in any way for choosing to participate or not to participate in the study. All of your responses will be kept confidential, and no information that could identify you will be included in the research report. Your responses will be anonymous, because at no time will you need to give your name. You will be allocated a code number instead. The assessment scores and questionnaires will not be seen or by any person at Headway at any time, and will only be seen and studied by myself and possibly my supervisor. The anonymous questionnaires and scores will be kept in a secure place throughout the study. In the event that this study is published in an academic journal, your responses and identity will be protected. You may refuse to answer any questions you would prefer not to, and you may choose to withdraw from the study at any point without penalty.

The assessment and questionnaires are designed to present little or no risk to you as a participant. This is supported by the fact that provision of a free counselling service will be available, if required, anytime after the assessment process. If you feel you need counselling after your participation, please let me know and a Headway counsellor will be made available for you.

This research will contribute to a larger body of knowledge on decision-making with a brain injury. If you are interested in the results, please let me know at the time of testing and I will meet with you after the research is finished and give you feedback. I will only be able to give you feedback in approximately six months time.

If you choose to participate in the study please fill in your details on the form below. For any further information I can be contacted telephonically on 082 376 7404 or via e-mail at cabuchanan@mweb.co.za and Professor Lucas, my supervisor, can be contacted at (011) 717-4539.

Yours sincerely,

Christine Buchanan

## APPENDIX B: Informed Consent Form

**Informed Consent Form**

I,_________________________________________ hereby consent to being assessed by Christine Buchanan for her study on decision-making styles in individuals with acquired brain injury from different economic backgrounds.

I understand that:

- Participation in this study is voluntary.
- That I may refuse to answer any questions I would prefer not to.
- I may withdraw from the study at any time I choose and there will be no consequences for withdrawing.
- No information that could identify me will be included in the research report, and my responses and assessment scores will remain confidential.
- In the event that this study is published, my identity and responses will remain confidential.
- There are no direct risks or benefits involved in my participation.
- Should I require counselling after my participation, a Headway counsellor will be made available for this purpose.

Signed__________________________

Date____________________________

## APPENDIX C: Demographic and SES Questionnaire

**ID Code: _____________ [Office use only]**

Dear Participant,

Please answer the following questions as truthfully as possible. This should not take you longer than 30 minutes.

The questions are split into two sections: Section A addresses your personal information, and Section B deals with economic aspects of your neighbourhood.

**Section A: Demographics**

| **Please circle the correct response:** | | |
|---|---|---|
| **1.** | **Gender** | |
| | Male | 1 |
| | Female | 2 |

| **2.** | **Race (for statistical purposes only)** | |
|---|---|---|
| | Asian | 1 |
| | Black | 2 |
| | Coloured | 3 |
| | White | 4 |

| **3.** | **Age in years** | | |
|---|---|---|---|

| **4.** | **Type of school** | |
|---|---|---|
| | Previous DET school | 1 |
| | Model C (previous government) or private | 2 |

| **5.** | **Education level** | |
|---|---|---|
| | Grades 1-2 | 1 |
| | Grades 1-2 | 2 |
| | Grade 3 (Standard 1) | 3 |
| | Grade 4 (standard 2) | 4 |
| | Grade 5 (standard 3) | 5 |
| | Grade 6 (Standard 4) | 6 |

| | | |
|---|---|---|
| | **Education level (continued)** | |
| | Grade 7 (Standard 5) | 7 |
| | Grade 8 (Standard 6/Form I) | 8 |
| | Grade 9 (Standard 7/Form II) | 9 |
| | Grade 10 (Standard 8 /Form III) | 10 |
| | Grade 11 (Standard 9 / Form IV) | 11 |
| | Grade 12 (Standard 10/ O-levels) | 12 |
| | 1st year university/college/technikon | 13 |
| | 2nd year university/college/technikons | 14 |
| | 3rd year university/college/technikons | 15 |
| | 4th (honours) year university | 16 |
| | University Masters | 17 |
| | University Doctorate | 18 |
| | Additional degree (years) | |

| | | |
|---|---|---|
| **6.** | **Handedness** | |
| | Left | 1 |
| | Right | 2 |

| | | |
|---|---|---|
| **7.** | **Type of injury** | |
| | Stroke | 1 |
| | Aneurysm (bleeding on the brain) | 2 |
| | Hypoxia (no oxygen to the brain) | 3 |
| | Traumatic, i.e. car accident/fall/violence | 4 |

| | | | | |
|---|---|---|---|---|
| **8.** | **Time since injury (in months)** | | | |

| | | |
|---|---|---|
| **9.** | **Length of coma** | |
| | < 1 hour | 1 |
| | 1 – 12 hours | 2 |
| | 12-24 hours | 3 |
| | 1-7 days | 4 |
| | Less than 1 month | 5 |
| | Less than 6 months | 6 |
| | 6 months or more | 7 |

| Narcotic induced? | | |
|---|---|---|
| | Yes | 0 |
| | No | 1 |

**How long after your injury could you remember from one day to the next the main things that happened to you and what you did?**

| **10.** | **Duration of PTA** | |
|---|---|---|
| | < 1 hour | 1 |
| | 1 – 12 hours | 2 |
| | 12-24 hours | 3 |
| | 1-7 days | 4 |
| | Less than 1 month | 5 |
| | Less than 6 months | 6 |
| | 6 months or more | 7 |

| **11.** | **Access to medical aid** | |
|---|---|---|
| | No | 1 |
| | Yes | 2 |

**Section B: Standard Of Living**

This section asks about the standard of living in your neighbourhood. We consider your neighbourhood to be the area approximately **20 minutes walk** or **2km** from your house.

The first question asks about LIVING STANDARDS in your neighbourhood.

1. Which of the following statements do you think is true about your neighbourhood?

| Response | **Please circle ONE option only** |
|---|---|
| There is a **big** mix of living standards | 1 |
| There is **some** mix of living standards | 2 |
| **Most** households have the same living standards | 3 |
| **All** households have the same living standards | 4 |

The next questions are about the MAIN TYPE OF HOUSING in your neighbourhood. We do not want to know about **your** house but the houses that are most common in your **neighbourhood**.

2. What type of housing is **most common** in your neighbourhood?

| **Response** | **Please circle ONE option only** |
|---|---|
| Shacks | 1 |
| Municipal/RDP housing | 2 |
| Flats (rented) | 3 |
| Bond townhouses/flats/complex (need a bank loan to buy) | 4 |
| Bond houses (need a bank loan to buy) | 5 |
| Other | 0 |

3. What type of security do **most** houses in your neighbourhood have around their property?

| **Response** | **Please circle ONE option only** |
|---|---|
| None | 0 |
| Bushes | 1 |
| Low wall | 2 |
| Wire fence | 3 |
| High Walls/palings | 4 |
| Electric fence | 5 |

The next questions ask about the FACILITIES in your neighbourhood. Remember that we consider your neighbourhood to be the area approximately **20 minutes** or **2km from your house.**

4. Do you think your neighbourhood needs more of any of the following:

(Please **tick** one box for **each** facility)

| **Facility** | **Yes [0]** | **No [1]** |
|---|---|---|
| 1. Primary school | | |
| 2. Secondary school | | |
| 3. Hospital | | |
| 4. Primary health clinic | | |
| 5. Community/recreational centre | | |
| 6. Sports field, pool or tennis courts | | |
| 7. Park (open grassed area) | | |
| 8. Street lighting in working condition | | |
| 9. Piped water supply | | |
| 10. Police officers patrolling your neighbourhood | | |

5. Where do **most** people in your neighbourhood do their **food shopping**?

| **Response** | **Please circle ONE option only:** |
|---|---|
| Market | 1 |
| Street vendor | 2 |
| Small shop/spaza shop | 3 |
| Supermarket | 4 |
| Other | 5 |

6. Where do **most** people in your neighbourhood do their shopping for **non-food items** e.g. clothes and electrical goods?

| **Response** | **Please circle one option only** |
|---|---|
| Market | 1 |
| Street vendor | 2 |
| Small shop | 3 |
| Supermarket | 4 |
| Shopping mall (not supermarket) | 5 |
| Other | 6 |

7. In general, do you think your neighbourhood has a PROBLEM with **<u>any</u>** of the following? (please **tick** one box for each problem)

| **Problem** | **Yes [0]** | **No [1]** |
|---|---|---|
| 1. Road safety – no pedestrian crossings, robots, etc. | | |
| 2. Sewerage | | |
| 3. Illegal dumping | | |
| 4. Pollution | | |
| 5. Overcrowding | | |
| 6. People born outside South Africa | | |
| 7. Homelessness | | |
| 8. Repossession (houses being taken away) | | |
| 9. Unemployment/retrenchment | | |
| 10. Prostitution | | |
| 11. Alcohol abuse | | |
| 12. Drugs | | |
| 13. Gangsters | | |
| 14. Shebeens | | |

## Thank you!

If you would like to know the results of this research, please tick the box below and I will arrange to meet with you to give you feedback. This will happen in March 2011.

☐

## APPENDIX D: Scoring protocol for the TTT

TINKER TOY TEST

PARTICIPANT ID:

| Variable | Criteria | Points | Score |
|---|---|---|---|
| 1. mc | Any combination of pieces | 1 | |
| 2. np | n <20 = 1<br>n < 30 = 2<br>n < 40 = 3<br>n<=50 = 4 | 1 – 4 | |
| 3. name | Appropriate = 3<br>Vague/inappropriate = 2<br>Post hoc naming, description = 1<br>None = 0 | 0 – 3 | |
| 4. mov | Mobility =1<br>Moving parts = 1 | 0 – 2 | |
| 5. 3d | 3 dimensional | 1 | |
| 6. stand | Free standing, stays standing | 1 | |
| 7. error | For each error, i.e. misfit, incomplete fit, drop and do not pick up | -1 | |
| Highest score possible | | 12 | |
| Lowest score possible | | -1 or less | |
| Participant's score (comp) | | | |

1. *mc*: whether participant made any constructions
2. *np*: total number of pieces
3. *name*: whether construction was given a name appropriate to its appearance and when
4. *(a) mobility*: wheels that work; (b) moving parts
5. *3d*: three dimensional
6. *Stand*: whether construction is free standing
7. *Error*: performance error i.t.o. misfit (parts of pieces forced together); incomplete fit (connection not properly made); dropping pieces on floor without attempting to recover them
8. *Comp*: total score based on all performance variables

## APPENDIX E: Permission from Headway Gauteng to conduct the Study

## (Hard copy only)

## APPENDIX F: Ethical Clearance Certificate for the Study

**(Hard copy only)**