The Chicken or the Harley: Specific Executive Functions in Risk Takers and Non-Risk Takers

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I declare that this research project is my own, unaided work. It has not been submitted before for any other degree or examination at this or any other university.

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Dedication

For my beloved father.

28/02/1946 – 29/11/2009.

You will be missed.

Abstract

The literature reports an association between substance use, a form of risk taking, and executive function deficits. In substance users, however, the direction of effect is unclear: substance use may cause, or be caused by, poor executive functioning. The current study examines affect intensity (implicated as an explanatory factor) and the executive functions inhibition, switching, and decision making in 20 Harley-Davidson riders (as risk takers) and 18 golfers (as normal controls) to set the stage for the direction of effect, chicken or egg problem to be answered. Relationships were found between group membership and the negative affect intensity and interference scores. The groups differed significantly on the negative affect intensity score. The researcher concludes that risk taking is associated with the intensity of negative affect and with inhibition alone. Future research into whether the relationship with the inhibition score translates into a real difference is implied as is investigation into the implications of the difference between the risk and non-risk taking groups in negative affect intensity. The stage is set for the chicken or egg problem to be answered. Directions for future research are supplied.

Introduction

Previous studies have found an association between damage to (or abnormalities in) the prefrontal cortex, manifesting as poor performance on a range of neuropsychological tasks (including those assessing the inhibition, switching and decision making factors identified in the literature; Verdejo-García & Pérez-Garcia, 2007), and the risky behaviour substance use. Risk taking has frequently been operationalised as substance use, but in substance abusers and dependents, the direction of effect is unclear: there is reason to believe that illicit drug use could lead to neurological damage (Garavan & Hester, 2007; Jentsch & Taylor, 1999). Alternatively, those who exhibit poor prefrontal cortex functioning may be prone to risky behaviours such as substance use and abuse (so poor executive functioning may lead to substance use) (Bechara & H. Damasio, 2002; A. R. Damasio, 1994). Replication of previous research was deemed necessary to solve the direction of effect, chicken or egg question that persists in the relationship between risk taking and executive functioning. In order to satisfy the need identified in the literature, the research had to be conducted in a functional population (operationalised as an economically successful group) which engaged in an alternative risk taking behaviour (which could not in and of itself alter executive or neurological functionality). The researcher aimed to shed light on this relationship, and pave the way for the chicken or egg question to be answered, by characterising the executive functions and affect intensity (implicated in decision making) of risk takers and comparing them to non-risk takers (Boyer, 2006). Risk taking was operationalised as riding a motorcycle; a brand linked with social success (Harley-Davidson Motorcycles) was chosen to facilitate the comparison to non-risk taking golfers.

As such, the researcher aimed to assess three aspects (inhibition, shifting and decision making) of executive functions as well as affect intensity (implied in decision making theory) in a sample of socially functional risk takers (Harley-Davidson riders) in order to replicate the

investigations conducted in risk taking samples who have typically failed to function optimally (substance users). The group of risk takers was compared to a group of socially functional non-risk takers (golfers) assessed on the same battery of tests to establish the existence and strength of the relationship between risk taking, operationalised as motorcycle riding, and executive function in order to guide future research and set the stage to answer the direction of effect question.

Literature Review

Executive Function

Recently, an understanding of the association between risk behaviour and cognitive and personality characteristics has been sought (Brand & Altstötter-Gleich, 2008; Skeel, Neudecker, Pilarski & Pytlak, 2007; Stanford, Greve, Boudreaux, Mathias & Brumbelow, 1996; Zuckerman & Kuhlman, 2000). Influential findings have emerged, yet flaws in the methods utilised, as well as in the chosen operationalisations of constructs and behaviours, have left gaps in the knowledge produced (Barry & Petry, 2008). The nature of the relationship between risk behaviours and prefrontal cortex functioning (cognitive and affective abilities, in particular) is one such gap. A clear enunciation of definitions and a review of the relevant literature follow.

The prefrontal cortex is widely acknowledged to be critical (V. Anderson, 1998; London, Ernst, Grant, Bonson & Weinstein, 2000) in effective executive processing: "it may be argued that the integrity of the prefrontal cortex is a necessary, but not a sufficient, condition for intact executive functioning" (P. J. Anderson, 2008, p. 6). The prefrontal cortex comprises the anterior frontal lobes (made up of the dorsolateral prefrontal cortex and the orbitofrontal and medial prefrontal cortex), and the anterior and ventral cingulate cortex (Miller, 2006). Overall, the prefrontal cortex is implicated in, "attention, planning, decision making, emotion, and personality" (Morecraft & Yeterian, 2002, p.22), but each of the regions of the prefrontal cortex has been identified with individual functions (Morecraft & Yeterian, 2002). The dorsolateral prefrontal cortex (also referred to as the lateral prefrontal cortex) has been implicated in spatial and representational memory and attention (Morecraft & Yeterian, 2002), "the motivational evaluation of sensory stimuli, the monitoring of the serial order of stimuli during the performance of self-ordered tasks" (Morecraft & Yeterian, 2002, p. 22), set shifting and self monitoring, and tasks which depend on

tactile, auditory and visual working memory (Jurado & Rosselli, 2007). Control of eye saccadic movement and visual attention, and the interpretation of the behavioural significance of stimuli have also been attributed to the dorsolateral prefrontal cortex (Morecraft & Yeterian, 2002).

The orbitofrontal and the medial prefrontal cortex are two distinct regions which are functionally similar and interdependent and thus tend to be grouped (with the anterior cingulate cortex; Morecraft & Yeterian, 2002) in functional research as the ventromedial prefrontal cortex (Happaney, Zelazo & Stuss, 2004). The ventromedial prefrontal cortex is involved in the affective and motivational skills, such as affective decision making (A. R. Damasio, 1994; De Luca & Leventer, 2008), and is thought to be responsible for the "reappraisal of the affective or motivational significance of stimuli" (Happaney et al., 2004, p. 2) after the initial appraisal is formed by the amygdale. The orbitofrontal prefrontal cortex, in particular, is the seat of "autonomic, emotional, response inhibition, and stimulus significance functions" (Morecraft & Yeterian, 2002, p. 23). Individuals with lesions in, or damage to, the orbitofrontal prefrontal cortex display deficits in reversal learning and response extinction tasks, persevering despite negative and absent reinforcement (Happaney et al., 2004). These patients also display deficits in social functioning; this implies that reappraisal plays a role in social interaction, in which adaptation to a variable environment is necessary (Happaney et al., 2004). The social and decision making deficits are less marked, or even absent, in patients with damage to the left ventromedial prefrontal cortex; the deficits in patients with bilaterial ventromedial prefrontal cortex lesions (like Elliot, below) are attributed to the effects of the damage on the right hand side (Happaney et al., 2004).

The cingulate cortex is a subset of the limbic cortex (Gabriel, Burhans, Talk & Scalf, 2002) and is necessary for "instrumental learning of goal directed [behaviour]" (Gabriel et al., 2002, p.

790). It "mediates associative attention to significant stimuli" (Gabriel et al., 2002, p.777) and is implicated in response selection and the retrieval of learned behaviours appropriate to a given context as well as in attentional (rather than visual) shifting (Gabriel et al., 2002; Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000). Associative attention is a product of learning, while executive attention (to which the anterior cingulate cortex, in particular, is linked) is required in novel or conflict-laden situations which may influence an individual's goals or plans. While not included in the memory and learning system, the cingulate cortex is implicated in these processes (Gabriel et al., 2002). The anterior cingulate cortex is also involved in the emotional response precipitated by the perception of pain, in the control of bodily arousal and in general monitoring behaviour (Jurado & Rosselli, 2007; Morecraft & Yeterian, 2002).

Development of the prefrontal cortex is completed late in the third decade of life (De Luca & Leventer, 2008). During adolescence (generally conceived as ages 13 to 19), the white matter of the frontal lobe increases in volume, while grey matter decreases in volume (Gogtay et al., 2004). It is thought that this decrease is the result of synaptic pruning, as it leads to a decrease in the synaptic density of the frontal lobe grey matter, and thus reflects cortical maturation (De Luca & Leventer, 2008). It may also, or alternatively, result from increasing intracortical myelination or a simple loss of neurons. This decrease in grey matter occurs last in the dorsolateral prefrontal cortex (Gogtay et al., 2004). This finding, and other evidence not reviewed here (see Gogtay et al., 2004), supports the hypothesis that "phylogenetically older cortical areas mature earlier than the newer cortical regions" (Gogtay et al., 2004, p. 8177) such as the prefrontal cortex. Thus, areas supporting the more basic capacities, such as spatial orientation, mature before those regarding affect and abstract problem solving.

The prefrontal lobe functions emerge around the end of the first year of life, reaching maturity in the third decade (Happanay et al., 2004). Adolescence is a time during which the changes of the pre-adolescence period continue and in which the frontal lobe, in particular, undergoes many developmental changes (De Luca & Leventer, 2008). By late adolescence, individuals are able to perform advantageously more quickly than individuals in early adolescence on affective decision making, yet are not yet able to perform advantageously as quickly as adults do (De Luca & Leventer, 2008). Early adulthood is characterised by further development and maturation of brain matter and peak executive function performance is found in the 20s (De Luca & Leventer, 2008). There is no clear increase or decrease in grey matter during adulthood, however, and it is hypothesised that neurogenesis and pruning balance out during this period (De Luca & Leventer, 2008). The affective skills are thought to develop and emerge earlier in childhood than the cognitive executive functions (De Luca & Leventer, 2008). The areas of the prefrontal cortex that subsume these functions mature last, however (De Luca & Leventer, 2008; Happaney et al., 2004).

The exact age at which age related decline in tasks requiring prefrontal cortex involvement begins is unclear (De Luca & Leventer, 2004). After the ages of 65 to 80, however, clear differences in executive and general cognitive function become apparent (De Luca & Leventer, 2004; Jurado & Rosselli, 2007). Lamar & Resnick (2004), for example, found that older individuals, adults over the age of 65, performed more poorly on tasks accessing functions located in the orbitofrontal (or ventromedial) prefrontal cortex than a group of younger adults. Some authors have found that higher education groups are less susceptible to this decline (see Jurado & Rosselli, 2007). Adults between the ages of 30 (the end of the third decade of life, into which myelination continues) and 65 appear to be comparable, although interpretation should be cautious if no age adjustment is available on tests utilised.

The orbitofrontal prefrontal cortex matures earlier in men than in women, and men tend to perform better on tasks that tap the functions of the orbitofrontal cortex than women (Happaney et al., 2004; Overman, 2004). This may be attributable to the increased right brain dominance displayed by males: the orbitofrontal cortex functions which are required for affective decision making are predominantly found in the right hand side of the orbitofrontal prefrontal cortex (Happaney et al., 2004). Overman (2004) hypothesised that the difference may be a result of females' avoidance of negativity (which manifests in the Iowa Gambling Task, described below) in which females avoided any card which included a loss, while apparently losing sight of the long term consequences of the choice. Alternatively, speculates Overman (2004), females may persevere on knowledge gained early in the task because they learn from the negative feedback received more slowly than males. It is not yet clear what causes the difference between males and females on such tasks.

Prefrontal cortex functioning and executive functioning have been treated as synonymous (V. Anderson, 1998); yet while related, they are distinct (Alvarez & Emory, 2006; Anderson, Anderson, Jacobs & Smith, 2008; Anderson, Jacobs & Anderson, 2008; De Luca & Leventer, 2008; Happaney et al., 2004; Stuss & Alexander, 2000). Executive function is best conceptualised as a psychological construct (Stuss, 1992) and includes "multiple, interrelated high-level cognitive skills" (P. J. Anderson, 2008, p. 3); executive function is therefore not a unitary construct even though it was once conceptualised as such (P. J. Anderson, 2008; Jurado & Rosselli, 2007; Stuss & Alexander, 2000). Executive functions include the initiation, organisation, monitoring and evaluation of, as well as flexible shifting between, goal-directed and problem solving behaviours and attention; the inhibition of alternative actions or stimuli; working memory and abstract reasoning; and the planning and selection of task goals (V. Anderson, 1998; V. Anderson, 2008; Barry & Petry, 2008; Gioia, Isquith & Kenealy, 2008; Jurado & Rosselli, 2007).

The above functions have been designated “cold” executive functions because they refer to the cognitive aspects of executive function (Anderson et al., 2008). Evidence from lesion studies and from A. R. Damasio’s Somatic Marker Hypothesis has led researchers to include additional capacities under the term executive function. The former, studies conducted in patients with acquired ventromedial prefrontal cortex damage, aimed to isolate those functions which were not intact in patients exhibiting damage in this area. One such patient, under the pseudonym “Elliot” (patient EVR elsewhere), suffered bilateral damage to the ventromedial prefrontal cortex as a result of the growth and removal of a meningioma (A. R. Damasio, 1994). The damage was more extensive on the right hand side of the brain involving the medial, orbital and the core white matter: damage to the left hand side was limited to the medial and orbital sectors. The basal forebrain, the motor and premotor cortices and Broca’s area and its surroundings were intact; as were the areas of the brain external to the prefrontal cortex (A. R. Damasio, 1994). Elliot’s damage is one of the most pure examples of ventromedial prefrontal cortex damage documented in the literature.

Before the surgery, Elliot was an intelligent and successful individual with a record of impeccable social behaviour (Saver & A. R. Damasio, 1991); after the surgery, he reportedly developed “acquired sociopathy” (Dunn, Dalgleish & Lawrence, 2006; Saver & A. R. Damasio, 1991, p. 1241). Elliot was unable to hold down a job, because he was unable to allocate his time effectively and reach a prompt and efficient decision on a choice of minimal importance (such as a mode of categorisation of files; A. R. Damasio, 1994). Elliot’s social conduct was “profoundly altered” (Saver & A. R. Damasio, 1991, p. 1242): he developed an inability to translate reasoning into decision making which resulted in a string of poor financial decisions uncharacteristic of the pre-operation Elliot. He did not learn from his poor decisions and seemed insensitive to negative feedback (A. R. Damasio, 1994). He was unable to maintain personal relationships and a string of

unsuccessful personal relationships followed his operation (A. R. Damasio, 1994). At first, he seemed emotionally contained, but A. R. Damasio (1994) discovered that Elliot's dysfunction included flat or absent affect. He was not concerned with Damasio's repetitive and lengthy questioning and was emotionally unaffected by the string of disasters that had characterised his life since his operation (A. R. Damasio, 1994). On the rare occasion that Elliot did experience happiness or anger, the feeling would be intense and fleeting (A. R. Damasio, 1994).

Elliot was tested extensively, and no cognitive deficits were found, yet he was unable to make decisions that would benefit him, especially in the social and personal realms (A. R. Damasio, 1994; Saver & A. R. Damasio, 1991). Because Elliot displayed no abnormality on any test pertaining to frontal lobe or cognitive functioning, Damasio and his colleagues developed a new assessment tool, the Iowa Gambling Task (the IGT; reviewed below) in an attempt to pinpoint Elliot's dysfunction in decision making. The IGT is a laboratory test that simulates real-life decision under conditions of ambiguity and uncertainty (Happaney et al., 2004). Although prior testing showed that Elliot was able to generate response options to a hypothetical dilemma, and could infer the consequences of each choice, he was unable to make a decision (Saver & A. R. Damasio, 1991). The IGT pinpointed the deficit: while he was able to surmise the consequences of any given choice, and he had free access to the social knowledge that had guided his actions before the surgery, he could not select an appropriate response option from those available (A. R. Damasio, 1994). No existing theory adequately explained Elliot's dysfunction, which was similar to that of Phineas Gage (A. R. Damasio, 1994). Damasio proposed the Somatic Marker Hypothesis as an explanation of Elliot’s case and of the cases of patients with similar damage and dysfunction (Saver & A. R. Damasio, 1991).

Theories regarding the "hot" executive functions in general, and affective decision making, in particular, are relatively new (De Luca & Leventer, 2008) and require exploratory investigation into their merits and applications (Dunn et al., 2006). The Somatic Marker Hypothesis utilised data from Elliot's case and performance on the IGT, as well as from patients with comparable damage and dysfunction (Saver & A. R. Damasio, 1991). The IGT involves a series of selections from four decks of cards; two of these decks have high rewards with higher punishments, and result in a net loss (the disadvantageous decks) while two of these decks, the advantageous decks, have lower rewards, but result in a net gain because of their correspondingly low punishments (see the Methods section for a more complete description).

On the IGT, normal controls tended to show an early preference for the high risk, disadvantageous decks before developing a preference for the low risk, advantageous decks in the later card selections (A. R. Damasio, 1994). Normal controls also developed higher skin conductance responses before selection (anticipatory skin conductance responses) of a card from the risk decks than they did before selecting a card from a low risk deck (Happaney et al., 2004). Since individuals are supposed to have no way (other than memory) of discerning the actual outcome of each of the 100 selections they make in the task, they must associate positive or negative outcomes with each deck that then guide selection and predispose the individual towards the less risky decks (A. R. Damasio, 1994). Individuals are also not given any method of keeping track of which decks are most advantageous, and the association with positive or negative outcomes is therefore assumed to be unconscious although this assumption has been questioned (Dunn et al., 2006). The patients with damage to the ventromedial prefrontal cortex, including Elliot, failed to exhibit a late preference for the low risk but advantageous decks and persisted in selecting high risk cards (A. R. Damasio, 1994). The patients also failed to develop greater anticipatory skin conductance responses when selecting a card from a high risk deck, although they did display elevated skin conductance after a loss or a gain,

unlike patients with damage to the amygdale (Bechara & H. Damasio, 2002; Happaney et al., 2004; Overman, 2004). These skin conductance responses have been conceptualised as somatic markers: bodily manifestations feelings that have been "connected by learning to anticipated future outcomes of certain scenarios" (Verdejo-García & Bechara, 2009, p. 49). A positive somatic marker will predispose the individual to choose the option it is attached to, while a negative somatic marker will do the opposite.

The Somatic Marker Hypothesis states that "emotional responses to positive and negative consequences guide [decision making] in risky and uncertain situations" (Boyer, 2006, p. 306), i.e. in situations in which a complete logical cost-benefit analysis is not possible (Dunn et al., 2006). This implies that, when faced with a choice between alternatives that are not distinguishable in terms of outcomes, the individual will be predisposed by the presence of somatic markers which mark the options as positive or negative, towards an option marked as positive. This theory is able to explain Elliot's dysfunction: because of his flattened affect, Elliot did not develop somatic markers and his resulting decision making landscape was flat. Each response option was equivalent to Elliot, because there was no negative or positive affect associated with any of the options (A. R. Damasio, 1994; Saver & A. R. Damasio, 1991). The result was that Elliot either displayed extreme procrastination in making decisions, or he made inappropriate decisions (Dunn et al., 2006). Damasio inferred that the ventromedial prefrontal cortex (which was damaged in Elliot) is responsible, and essential, for the creation and use of somatic markers in decision making (1994). In Happaney et al.'s terms, individuals with ventromedial prefrontal cortex damage performed poorly on the Iowa Gambling Task because their reappraisal of the motivation significance of stimuli was impaired (2004). This function is attributed to the prefrontal cortex (Happaney et al., 2004), and the argument is not incompatible with the Somatic Marker Hypothesis. The result of the Iowa Gambling Task experiments has been the recognition of additional executive functions (attributed to the prefrontal

cortex in the anatomical discussion above). These "hot" executive functions refer to the social or affective functions such as decision making in the social and personal realms (A. R. Damasio, 1994).

As a result of lesion studies and recent theories like the Somatic Marker Hypothesis, additional executive functions such as emotional regulation have been recognised (Anderson et al., 2008; A. R. Damasio, 1994; De Luca & Leventer, 2008; Zelazo, Qu & Muller, 2004). The Somatic Marker Hypothesis has recently been used to explain addiction to illicit substances on the basis of the "myopia for the future" or disregard of future consequences displayed by both substance users and patients with ventromedial prefrontal cortex lesions (Verdejo-García & Bechara, 2009). With this theoretical basis, an emphasis on more practical issues is necessary. A description and analysis of the exact constructs and methods of measuring the executive functions follows.

Dysfunction of the prefrontal cortex has been assessed via neurological scans (Anderson et al., 2008; Bolla, Eldreth, Matochik & Cadet, 2005; Liu, Matochik, Cadet & London, 1998) and neuropsychological batteries (V. Anderson, 1998; Barry & Petry, 2008). Functional Magnetic Resonance Imaging (fMRI), Positron Emission Tomography (PET) and regional cerebral metabolic rate for glucose (rCMRglc) imaging studies reveal the rapidly changing distribution of blood, oxygen, or glucose in various regions of the brain, thus yielding data regarding functioning by location on the assumption that increased blood or oxygen flow or glucose use signify increased activity (Bolla et al., 2005; London et al., 2000; Reisberg, 2001; Wood & Smith, 2008). Magnetic Resonance Imaging (MRI) and Computed Axial Tomography (CAT), in turn, produce data regarding brain structure (Bolla et al., 2005; Reisberg, 2001; Wood & Smith, 2008). Neuropsychological batteries treat executive function as a psychological construct and link specific tasks to particular functions in the brain, often without specifying (or without being able to specify) a precise physical site (Alvarez & Emory, 2006;

V. Anderson, 1998; Anderson et al., 2008; Phillips & Henry, 2008; London et al., 2000; Spinella, 2004); when testing functional performance, and taking into account the variety of brain regions involved in even simple tasks, this lack of specification of brain site is not problematic (Bechara, Dolan & Hindes, 2002).

The executive functions are often grouped into three distinct, but related functions: shifting mental sets (henceforth shifting), the monitoring and updating of the representations of working memory (henceforth updating), and the inhibition of prepotent or dominant responses (henceforth inhibition) (Miyake et al., 2000). While these three (and with the inclusion of decision making, four) constructs do not exhaust the functions designated executive, they represent a large portion of the relevant capacities (Miyake et al., 2000).

Miyake et al. (2000) report that the correlations between tests of executive functions typically fall at or below r=.4 and often fail to achieve statistical significance. Although this may be the result of the non-unitary nature of executive function (Jurado & Rosselli, 2007; Stuss & Alexander, 2000), Miyake et al. (2000) caution that a number of alternative conditions could explain the low correlations. Firstly, one of the methods of analysing the overlap between the factors is exploratory factor analysis in which the experimenters factor analyse the manifest variables, such as the results of the tests themselves, rather than the latent variables which are supposed to underlie the manifest variables. Analysing the manifest variables involves including the variance that does not relate to the executive functions, but is the result of various non-executive functions, such as working memory, which are required in the task (Miyake et al., 2000). The inclusion of this non-executive variance implies that different tests of executive functions, each of which requires a different subset of executive and non-executive abilities, will correlate less as manifest variables

than as the latent variables which underlie them. A reduction in the correlations between manifest variables will result.

Secondly, executive functions are implicated on novel tasks, therefore test-retest reliability coefficients on neuropsychological tests are likely to be lower than expected as repetition of the task is required and the executive functions may be less involved in the second administration of the test (Miyake et al., 2000). Measures of executive function may not attain reliability because the problems presented cease to be novel after the first administration (Jurado & Rosselli, 2007). Thirdly, it is thought that individuals may utilise different strategies across or within testing sessions on neuropsychological tests (Miyake et al., 2000). Finally, the specificity and sensitivity of a test have an inverse relationship and neuropsychological tests may aim to be sensitive, rather than specific, to a particular executive function (Dunn et al., 2006). This implies, as noted above, that the task is an impure test of an executive function as it requires various underlying abilities of a non-executive nature: because "executive functions necessarily manifest themselves by operating on other cognitive processes, any executive task strongly implicates other cognitive processes that are not directly relevant to the target executive function" (Miyake et al., 2000, p. 52). As such, widely used neuropsychological tests like the WCST and Tower of London have not been conclusively shown to be construct valid (Miyake et al., 2000) as this implies the exclusion of non-construct variance. When testing inhibition, for example, there are a variety of non-executive cognitive skills that are involved and tapped by the test. This problem arises from the poorly defined construct of executive function itself (Jurado & Rosselli, 2007). These conditions lower the test-retest and internal consistency coefficients of many neuropsychological tests (Miyake et al., 2000). Low reliability coefficients will also produce lowered correlations with other tests; this should be kept in mind when interpreting neuropsychological test results (Miyake et al., 2000).

In response to these problems, Miyake et al. (2000) conducted a latent variable factor analysis using widely used tests of executive function. They then applied structural equation modelling as an "independent empirical test of previous proposals regarding the nature of executive function(s) tapped by [a selection of] complex executive tasks" (Miyake et al., 2000, p. 61). Miyake et al.'s results suggested that the latent variables updating, shifting and inhibition were indeed separate but related constructs, although the authors do not claim that these factors exhaust all possible executive functions (2000). The relationships between these may be the result of the involvement of non-executive functions such as working memory or the role of inhibition of unnecessary information or mental sets in all executive tasks (Miyake et al., 2000). Regardless, Miyake et al.'s results confirm the non-unitary nature of the latent variables underlying the selected tests (2000).

Following Miyake et al. (2000), Verdejo-García and Pérez-Garcia (2007) studied the factor structure of a selection of executive function tests, and suggested a fourth factor: that of decision making. They included decision making in the analysis on the basis of the differences in the literature between substance users on decision making tasks and on the basis of the absence of significant correlations between decision making and the other executive functions (2007). They conducted a factor analysis in substance dependent individuals, known to perform poorly on tasks of executive function, on a range of tests which access the executive functions. They also included normal controls in their sample. One of their hypotheses was that a fourth factor, decision making, would be found in substance dependent individuals and normal controls.

Verdejo-García and Pérez-García's model confirmed the division of the executive functions into decision making, updating, inhibition, and shifting (2007). The analysis included the WCST, the

Stroop, and the IGT (Verdejo-García & Pérez-García, 2007) as well as a variety of other neuropsychological tests. All the tests, when subjected to factor analysis, loaded at .5 or higher on one of the four factors. The results replicated the three factors found by Miyake et al., 2000, and introduced a fourth, the decision making factor, on which the IGT alone loaded.

Miyake et al.'s (2000) latent variable analysis showed that the WCST and Stroop could be used as sensitive and adequately specific tests of shifting and inhibition respectively, despite the persistent task impurity that affects most tests purporting to tap the executive functions (Jurado & Rosselli, 2007). The task impurity problem is pervasive across tests of executive function precisely because "the integrity of the whole brain is necessary for optimal performance on executive tasks" (Jurado & Rosselli, 2007, p. 217) and more than the executive functions are required to complete the tasks.

Inhibition involves the deliberate suppression of automatic, prepotent or dominant responses (Miyake et al., 2000). One test of inhibition is the well known Stroop Colour-Word Interference Test which measures the individual's susceptibility to cognitive interference (Miyake et al., 2000). Because age related deficits have been found in older adults on the Stroop (Phillips & Henry, 2008), an age adjustment formula is included in the test. Additional differences in the age groups can therefore be cautiously attributed to real differences between younger and older adults (Macleod, 1991). The Stroop is a fairly pure measure of inhibition (loading at r=.43 on the latent variable) which does not load significantly on any other latent variable (Miyake et al., 2000). There are no sex differences in the interference score produced by the Stroop (Macleod, 1991).

Decision making, as explained by the Somatic Marker Hypothesis, is best measured using the Iowa Gambling Task (IGT): the IGT is sensitive to dysfunctions in decision making where other tests of executive function fail to detect any impairment (A. R. Damasio, 1994). The IGT is a sensitive measure of affective decision making (Buelow & Suhr, 2009). Neither test-retest nor internal consistency reliability coefficients are appropriate measures of the quality of the IGT, as the construct is not stable (the individual learns throughout the task) and the executive function of decision making may not be required in repeated administrations when the task is no longer novel (A. R. Damasio, 1994; Miyake et al., 2000). Verdejo-García and Pérez-Garcia's (2007) exploratory factor analysis showed that the IGT loaded (at r=.89) on one separate factor, and is thus a separate construct from the shifting, updating and inhibition factors analysed.

Executive (rather than visual) shifting involves disengaging from a previously relevant, and now irrelevant task set, and engaging with a new appropriate task set. This seems to involve overcoming learnt and proactive interference or negative priming (Miyake et al., 2000), and to "use environmental feedback to shift cognitive set" (Strauss, Sherman & Spreen, 2006, pp. 526-527). The Heaton (1993) standardised version of the WCST, originally developed in 1948 by Berg and Grant, is one of the most frequently used tests of executive functions and has been applied extensively frontal lobe patients and normal populations (Miyake et al., 2000). The number of Perseverative Errors score, one of the scores that the WCST produces, is considered to be highly sensitive to frontal lobe dysfunction (Miyake et al., 2000). The Conceptual Level Responses score serves as a measure of the individual's understanding of the test. The WCST has been described as the best test of frontal lobe function available (reported in Bowden et al., 1998) and has been shown to be highly sensitive to the executive function shifting (Miyake et al., 2000). The WCST and the other psychometric indices employed in the current study are reviewed in the Methods section.

Affect Intensity refers to the strength rather than the frequency of emotions that an individual experiences (Larsen, 2009). The Affect Intensity Measurement (AIM, produced by Larsen & Diener, 1987) is a measure of trait, rather than state, affect intensity and is correlated at *r*= .45 with the Emotional Intensity Scale (created by Bachorowski & Braaten, 1994). The AIM has consistently produced higher validity coefficients than the alternative measurements of the affect intensity construct (Larsen, 2009). With good internal consistency, split-half reliability and test-retest reliability (presented in the Methods section), the AIM is widely used in the assessment of affect intensity (Larsen, 2009).

According to Verdejo-García and Pérez-García's (2007) factor analysis of executive function tests (and according to Miyake et al., 2000), the Stroop, WCST, and IGT measure three of the four factors of the executive functions, namely inhibition, shifting, and decision making. The fourth factor, updating, is closely linked to working memory and is associated with dorsolateral prefrontal cortex function (Miyake et al., 2000). Updating maintains task-relevant information and dynamically manipulates the contents of working memory, while also conducting temporal sequencing and monitoring of the working memory function (Miyake et al., 2000).

Given the poor reliability and validity of the majority of the tests of executive function available to clinical and research practitioners, and given the utility of research into the executive functions in treatment and rehabilitation following organic or substance-induced damage or dysfunction, the disadvantages of utilising poorly validated, but sensitive tests such as the WCST, seems to be somewhat ameliorated. The test procedures are described under the Instruments section of the Methods chapter.

Risk behaviours

Risky behaviours are behaviours that compromise (or increase the probability of adverse effects on) health, well-being or life course (Jessor, 1998); they include deleterious or rebellious behaviours and thrill seeking behaviours such as gambling, aggressive behaviour, substance use, early or promiscuous sexual activity, motorcycle riding and extreme sports; immediate gratification may be selected at the expense of deferred gain in participation in these activities (Bechara et al., 2002; Jessor, 1998; Stanford et al., 1996; Skeel et al., 2007; Verdejo-García & Bechara, 2009; Zuckerman & Kuhlman, 2000). A failure to learn from repeated mistakes may also characterise the risk behaviour (Verdejo-García & Bechara, 2009). This is a necessary simplification of the dimensions and definitions of risk taking available in the literature (Leigh, 1999); given that it is neither the individual's perception of risk (Adlaf & Smart, 1983), nor their propensity for risk taking (often explained by referring to the personality construct sensation seeking; Zuckerman & Kuhlman, 2000) that was under study here, the brevity of this definition, relative to the scope of risk taking examined, was justified.

Risky behaviours have been linked conceptually and empirically with poor decision making and planning (Ersche, Clark, London, Robbins & Sahakian, 2005; Grant, Contoreggi & London, 2000; Plax & Rosenfeld, 1976) and with executive functions in general (Barry & Petry, 2008). Substance use is a form of risk behaviour often studied in social science research (Leigh, 1999). Researchers have found a positive relationship between substance use and prefrontal cortex damage manifesting in poor executive functioning (Bechara, 2003; Barry & Petry, 2008; Liu et al., 1998; London et al., 2000). Hypo-activity of the prefrontal cortex, responsible for the executive functions, has also been found in substance dependent individuals, in relation to thoughts about future negative consequences (Bechara & H. Damasio, 2002). The select short term benefit at the expense of long term gain displayed by substance users is reminiscent of Elliot's "myopia for the future". Verdejo-

García and Bechara's work suggests that the poor decision making displayed by substance users may be result from a lack of consideration of the long term consequences of an action (as a result of hypoactivity of the prefrontal cortex) rather than as a result of absent somatic markers (2009). This conjecture requires further testing.

Aspects of poor executive function are associated with polysubstance use (Bechara & H. Damasio, 2002; Liu et al., 1998; Overman, 2004; Verdejo-García & Pérez-García, 2007), marijuana use (Bolla et al., 2005; Gonzalez, 2007; Lundqvist, 2005), opiate use (Ersche et al., 2005; Gruber, Silveri & Yungelun-Todd, 2007) and cocaine use (Garavan & Hester, 2007). Substance use has also been linked to abnormal prefrontal functioning, as assessed by the neuroimaging techniques PET and rCMRglc (regional cerebral metabolic rate for glucose as a measure of local brain function) (London et al., 2000). In general, patients with damage to the prefrontal cortex may exhibit dysfunctions in a subset of executive functions while other cognitive and executive functions remain intact (A. R. Damasio, 1994). Poor executive functioning may present as weak inhibition (or high interference on the Stroop test), poor, or risky, decision making (low final score on the Iowa Gambling Task), and high Perseverative Errors on the WCST (given understanding of the test, as indicated by a typical number of Conceptual Level Responses).

Neurological scans reveal the structure of the brain, the moment-by-moment functioning of the brain, and allow the inference from brain function (measured by amount of blood, oxygen or glucose by location) to the function-structure relationship (Reisberg, 2001). So, if the prefrontal cortex is activated during a task known to measure decision making, then the inference is made that the prefrontal cortex area is responsible for, or involved in, the decision making function (Reisberg, 2001). Neuropsychological assessments access the function itself, without trying to specify the

location in the brain in which the function occurs. As such, there is no inference required. Neuropsychological tests are able to access the function in question without relying on the knowledge base that links structure and function in the brain (Price & Friston, 2001). In exploratory research, both imaging studies and neurological or neuropsychological tests are needed; but where the function itself is of interest, neuropsychological tests are the more appropriate method of investigation. Since the degree and extent of the damage in patients differs in each case, so the dysfunction is specific to the individual (Price & Friston, 2001). As such, damage to the prefrontal cortex manifests in different ways in different groups of individuals; the overall pattern, however, is one of executive dysfunction following damage to the prefrontal cortex (Dunn et al., 2006; Alvarez & Emory, 2006).

The misunderstanding that attitude towards risk, rather than dysfunctional decision making which results in risk behaviours, is implicated in the Somatic Marker hypothesis is common. This misunderstanding is found, for example, in Leland and Grafman's (2005) test of the Somatic Marker Hypothesis which reveals no differences between patients with ventromedial prefrontal cortex lesions and normal controls, on a measure of attitudes towards risk (a construct not implicated in the Somatic Marker Hypothesis). The experimental tests employed by Leland and Grafman (2005) are not intended to tap into the response selection tested by the IGT and their laboratory tests lack the ambiguity and uncertainty that renders the IGT useful in identifying the dysfunction these individuals show. In addition, the test of risk seeking employed does not involve the positive or negative consequences necessary for the development of somatic markers (A. R. Damasio, 1994). In short, Leland and Grafman test a hypothesis that the Somatic Marker Hypothesis does not imply. A clear distinction is needed, in the literature, between poor decision making as a result of lesions or dysfunction of the neural circuitry underlying the executive functions, and attitudes towards risk which predispose the individual towards risk behaviours. The former is within the bounds of

neuroscience and is tested with structural and functional modelling and testing, while the latter is a matter of personality, and may be assessed alongside the personality construct sensation seeking.

As such, substance use has been linked with poor prefrontal cortex functioning, and in turn, with poor executive functioning. Other risk behaviours have not been studied as extensively as substance use, yet the relationship between risk taking and executive function may not persist beyond substance use. Assessment, via neuropsychological testing, is necessary to determine whether risk behaviours in general are linked with poor executive functioning.

The Chicken or Egg Problem

Studies conducted in substance users have one fundamental problem: the nature of the risk behaviour (substance use) chosen precludes a clear conclusion regarding the direction of effect between substance use and executive function (Bechara & H. Damasio, 2002; Bolla et al., 2005; Liu et al., 1998). There is reason to believe that illicit substance use could lead to neurological damage (Garavan & Hester, 2007; Jentsch & Taylor, 1999); however, those who exhibit poor prefrontal cortex functioning are prone to poor decisions; this may include risky behaviours such as substance use and abuse (Barry & Petry, 2008; Bechara & H. Damasio, 2002; A. R. Damasio, 1994). This is a variation of the chicken or egg problem (Barry & Petry, 2008); it may be resolved by replacing the risk behaviour substance use with an alternative risk behaviour.

The population of substance users tends to be socially dysfunctional: substance users display lower levels of work productivity (Ghodse, 2005), and substance use is related to psychological and psychiatric disorders (Parry et al., 2004; Swendsen & Merikanges, 2000) as well as to poor peer

relations, self-control and coping skills (Niaz et al., 2005); therefore, research in this group will have limited implications for socially functional populations. Further research should select an alternative risk behaviour in a functional sample. Motorcycle riding has been classified as risky (Adlaf & Smart, 1983) on the basis of the increased probability of accidents and harm as a result of choosing to ride a motorcycle instead of driving a car (which is not, on Jessor's definition, without risk; 1998): individuals riding motorcycles in the United States of America, for example, were over four times more likely to die in traffic collisions than passenger car drivers in 2004 despite accounting for only 0.3% of distance travelled (Paulozzi, 2005; National Highway Traffic Safety Administration [NHTSA], 2006). Similar results have been found in the United Kingdom (Crundall, Bibby, Clarke, Ward & Bartle, 2008) and Australia (Langley, Mullin, Jackson & Norton, 2004). In addition, two conditions observed at the Harley-Davidson dealerships convinced the researcher of the risky nature of riding a Harley-Davidson motorcycle: riders consistently classified riding a Harley-Davidson as a "thrill seeking" behaviour; and the emphasis on safety procedures at the handover of a motorcycle to a new owner as well as during the pre-ride briefing (which occurs just before the "pack" of riders goes out on a communal ride) indicate an awareness of the high risk involved in riding. Members of the Harley Owners Group (HOG) and Steel Wings club display this recognition which is coupled with the belief that the risk involved is being managed via adherence to rules of pack conduct and the use of appropriate clothing.

Motorcycle riding and substance use are similar on the following dimensions: the behaviours they choose are (at least initially in the case of substance use) voluntary and may result in death (Parry et al., 2004); both are costly activities involving the consumption of a luxury item rather than a necessity (motorcycle riding may be a necessity and a luxury); both have been chosen by participants out of a range of alternative behaviours (alternatives include sporting activities, social engagements and, for motorcycle riding in particular, driving a car) possibly (but not necessarily) for

the immediate pleasure participation engenders (at the risk of long-term loss); the initiation and continuation of both behaviours is liable to be influenced by peers and other participants; and both are recreational activities (only HOG and Steel Wings group members who actively participate in riding as a recreational activity were approached). The substance users and motorcycle riders differ in two ways: one group chooses an illegal, and the other a legal, activity; and crucially, one activity (substance use) has an inherent impact on brain functioning (Garavan & Hester, 2007; Jentsch & Taylor, 1999) which the other behaviour (motorcycle riding) typically lacks.

Risk taking, thus defined, needs to be considered anew in relation to executive function. While past research has utilised substance users as a risk taking population, the current study aims to begin addressing the chicken or egg problem identified in the literature in an alternative risk taking population. The alternative risk behaviour utilised here was motorcycle riding.

Rationale for the Current Study

A knowledge gap has been identified. In order to address this gap, research is needed to determine, firstly, whether or not the relationship between risk taking and executive function persists beyond a substance using population, and secondly, if the relationship persists, whether or not risk taking affects executive function, or vice versa. The current study addressed the first of these concerns, which is a necessary precursor for the second. There are two questions which emerged from the first of these concerns. The first of these was, is there a relationship between risk taking, executive functioning and affect intensity? The second was, does the performance of risk takers differ significantly from that of non-risk takers on an inhibition task, a shifting task, a decision making task and an affect intensity task? The literature review lead the researcher to expect that if prefrontal cortex functioning (and so executive function) differs in risk takers, then risk takers will

differ from non-risk takers on a measure of inhibition (measured with the Stroop), on a measure of decision making, on performance on a switching task (in particular, the number of Conceptual Level Responses and the number of Perseverative Errors on the WCST) and will differ on affect intensity (on the AIM). The researcher expected that the risk takers would experience more interference (and so, show weaker inhibition, on the Stroop), would make more risky decisions (and therefore choose fewer advantageous cards on the Iowa Gambling Task), would commit more Perseverative Errors on the WCST (although the Conceptual Level Responses score, as a measure of understanding of the task, should be equal to non-risk takers' scores) and would report higher overall affect intensity than non-risk takers.

The researcher aimed to assess specific executive functions in a socially functional risk taking sample. The target population of neurologically normal (in the sense of displaying an absence of any known structural or functional abnormalities) and socially functional individuals was chosen so as to allow for inferences from the current study to other studies involving normal populations. The population to be accessed was selected with socioeconomic success in mind because this implied functionality in society; neurological normality was ensured via screening of the population from which a sample was drawn. The population of motorcycle riders that typically met the criterion of socioeconomic success (as indicated by occupational prestige and high income; Strenze, 2007) was the Harley-Davidson population. This brand is linked with recreational, as well as daily, use; the motorcycles are expensive and this implies that only socioeconomically successful individuals will be able to purchase a Harley-Davidson.

In previous research, normal or socially functional samples have comprised or included adolescents, undergraduates and young adults in whom myelination of the prefrontal cortex may be

incomplete (Stuss, 1992) (this process continues well into the third decade of life; De Luca & Leventer, 2008). A mature sample was warranted; one in which cognitive development (neurogenesis, pruning and myelination) was complete (De Luca & Leventer, 2008), and thus only individuals between the ages of 30 and 65 were included.

Previous authors have used a variety of neuropsychological tests; specific tests have been used consistently, however, and these tests were used in the current sample in order to render results comparable (see Bechara et al., 2001; Bechara et al., 2002). The tests were chosen as the best options available for assessing the constructs under investigation. Specific executive functions have been, and were here assessed using the Stroop Colour-Word Interference test (Stroop), the Wisconsin Card Sorting Test (WCST), and the Iowa Gambling Task (IGT) (Bechara et al., 2002). These tests assessed inhibition, shifting, and decision making (V. Anderson, 1998), in order. In addition, the Affect Intensity Measurement (the AIM) was utilised as a measure of the "individual differences in the characteristic magnitude of emotion reactions" (Larsen, 2009, p. 274) in order to determine whether this was elevated in risk takers (Boyer, 2006).

The final latent factor identified by Miyake et al. (2000), updating, was not measured as it was beyond the scope of the current study. The factors shifting, inhibition, and decision making were assessed alongside affect intensity, in Harley-Davidson riders and in non-risk taking golfers. No hypotheses were put forth as the current research was exploratory and the imposition of hypotheses was, in many cases, unwarranted on the basis of the evidence reviewed. The researcher instead examined the data without imposing hypotheses to order to findings and limit the focus of the current study.

Methods

Sample and Sampling

A purposive, non-probability and snowball sampling strategy using was used. The target group comprised neurologically normal individuals of age 30 to 65 (to ensure maturity without excessive age-related degeneration predominantly found after the age of 65 to 80; De Luca & Leventer, 2008; Jurado & Rosselli, 2007; Phillips & Henry, 2008) with no recent history of illicit substance use. To ensure this neurological normality and lack of substance use, participants were screened for known neurological and psychiatric disorders, as well as substance use (in the last five years) or any history of substance dependence (hospitalisation or rehabilitation for substance use), colour-blindness, concussion in the 30 days prior to testing, and any incidents of head injuries resulting in loss of consciousness (Basso, Bornstein & Lang, 1999) as these conditions could confound the results (Ersche et al., 2005). The term neurological normality, as used here, did not imply any requirements regarding performance on tests of executive functioning and affect intensity, but implied that obvious causes of neurological impairment were excluded. Thirty-eight individuals were tested; 20 of these were in the risk taking group, and 18 were in the non-risk taking group. Individuals who both owned and rode a Harley-Davidson Motorcycle and were, at the time of testing, active and participating members of the local HOG (Harley Owners Group) or Steel Wings group comprised the risk taking sample while a control group (roughly equivalent in terms of socioeconomic success) comprising golfers (members of a golf club) formed the non-risk taking sample (Schrembi, 2008). Golf was chosen on the basis of various similarities with riding a Harley-Davidson: both activities are voluntary, and the condition that Harley-Davidson riders were active and participating HOG or Steel Wings members ensured that both were recreational activities. Both of the activities have substantial costs attached to participation and to membership in a relevant club. Only golfers who belonged to a golf club were included as this entailed a serious interest in the activity. Both activities have a strong social component involved in participation. Golf, however, is a

non-risky behaviour. The risk taking group was approached at various dealerships in Johannesburg with the aid of a confederate who is known to the HOG club.

Procedure

Data collection commenced in July 2009 with the risk taking group. Each potentially eligible participant, i.e. any individual who both owned and rode a Harley-Davidson, and was an active participating member of either the HOG or Steel Wings group, was approached and invited to participate. Each individual was given a brief statement of the purpose and method of the study, in verbal and written form (see Appendix A for the risk taking group): the document described the nature of the testing, and the time period that participation entailed and stated that experiencing difficulty on these tests did not imply damage to or abnormality in the brain or executive functions. After informed consent (see Appendix C) had been attained, the researcher administered the demographics inventory and examined the background information provided in response to questions posed in the forms to ensure that no exclusion criteria were met. Individuals who met any one of these exclusion criteria were not tested further and were told that their results would not provide an accurate representation of their cognitive or affective abilities and would not be comparable to other individuals in the sample.

Data were recorded via one self-report test and three psychometric tests. The demographics inventory (see Appendices D and E), IGT (see Appendix F), Stroop (see Appendices G and H), WCST (see Appendix I) and AIM (see Appendix J) were administered by the researcher; the order of testing was standard across groups. Testing time ranged from 20 minutes to 65 minutes with the majority of the sample requiring 30 to 45 minutes.

In the risk taking group, participants indicated that the testing procedure was excessively long. This was due to the lengthy nature of the computerised version of the Stroop administered to the first seven participants in the risk taking group; given various difficulties experienced in obtaining data, and the complicated nature of the results rendered by the computerised version of the Stroop, the researcher replaced this version with the manual version of the test. This allowed for swift administration (a testing time not exceeding 5 minutes per participant as opposed to the 20 minute administration of the computerised version). Analysis of the results of the initial seven participants on the computerised Stroop test (all of whom were in the risk taking group) indicated that the results of the computerised task were not comparable to those of the manual Stroop; results were given in reaction time, rather than the traditional scoring method, and were not amenable to age adjustment (deemed necessary in this sample) or comparison to norms published for the manual test. The WCST score, Failure to Maintain Set, was proposed as a proxy for the Stroop Interference score; this proposal was tested in the Results section. The reduction in statistical power that resulted from the exclusion of these seven individuals was minimal; results from the Stroop were interpreted with the reduced sample size in mind. The procedure for the non-risk taking group mirrored that of the risk taking group; however, the manual version of the Stroop was used throughout (see Appendix B for the information sheet given to individuals in the non-risk taking group).

Instruments

(For examples of items from each scale to be used in the study, please see Appendices F, G, H, and I. Full scales, except for the AIM in Appendix J, could not be reproduced due to copyright restrictions.)

The demographics inventory, administered once informed consent had been obtained, recorded the individual's gender, age in years, handedness, highest educational level attained, age at first purchase of any motorcycle and of a Harley-Davidson (if applicable), current Harley-Davidson model (if applicable), and current career title (Evans, Kemish & Turnbull, 2004). It also served to screen the sample for illegal substance use, head injuries resulting in loss of consciousness, known neurological or psychiatric disorders, and, in the control group, risky behaviours (participation in extreme sports, recreational substance use in the last 5 years and any other behaviour considered risky). The questions regarding risk behaviours which were included in the demographics inventory were identical for the two groups. For the risk taking group, these questions served to confirm that the group chosen as risk takers did, in fact, engage in risky behaviours. In the non-risk taking group, the risk related questions served to exclude those golf club members who, in addition, engaged in risk behaviours and so were not part of the target population. An additional open-ended question was included in the Harley-Davidson demographics questionnaire.

The Iowa Gambling Task (the IGT) was used as a complex decision making task which mimics real life decision making (Barry & Petry, 2008; Dunn et al., 2006; Saver & A. R. Damasio, 1991). The task taps a function of the orbitofrontal or ventromedial prefrontal cortex (Lamar & Resnick, 2004). The computerised version of the task (which is not significantly different from the standard version; Evans et al., 2004; Fernie & Tunney, 2006) presented the individual with four decks of cards while the researcher provided a set of standardised instructions (provided in Balodis, MacDonald & Olmstead, 2006). The individual's score was calculated for the task as a whole and for each of the 5 blocks of 20 card selections (Dunn et al., 2006). Facsimile, rather than real, money was used, as no difference has been found between reinforcer types (Fernie & Tunney, 2006). Given the consistent difference between males and females in the literature, a gender difference on the IGT was anticipated in the current study (Overman, 2004). Like the WCST, the IGT elicits a learning effect and

it is therefore not appropriate to evaluate it via internal consistency or a test-retest coefficient. The test is known to be sensitive to dysfunction of the executive functions, and Dunn et al. (2006) report that the test results are robust across different schedules of reward and punishment. The construct validity of the IGT is still under investigation: while the factor loads separately in latent factor analysis (Miyake et al., 2000), the task is relatively new and its validity has been questioned (Dunn et al., 2006). The IGT is sensitive to dysfunction in decision making, especially, but not exclusively, in patients who have suffered damage to the prefrontal cortex (A. R. Damasio, 1994; Dunn et al., 2006).

The Stroop (Stroop Colour-Word Interference test) was used to assess the ability to inhibit a pre-potent response (Bechara, 2003). In the Golden version (published 1978) of the Stroop, participants first read colour names (blue, red and green) printed in black ink, then named the colours in which non-words were printed, and finally named the colour of the ink without reading the word presented (which was always a conflicting colour name) (Strauss, et al., 2006). The first two conditions act as baseline measurements against which the third condition is compared to produce an interference score (the sole score produced by this test). The raw test score was used in all analyses as these scores account for differences in reading and processing speed, and have been adjusted for age-related differences in overall cognitive speed, and the use of raw scores maintains variance (which might be lost in the t-converted scores); this is vital in a sample of this size. The Stroop loaded significantly at r=.43 Miyake et al.'s the inhibition factor (2000) and has elsewhere been shown to have moderate to high internal consistency (Strauss et al., 2006). In terms of criterion-related validity, the Stroop correlates with other measures of prepotent response inhibition (r=.33 and .56 with the stopping probability and time of the stop-signal task), and taps a construct similar to the ability to resist interference from irrelevant information (Strauss et al., 2006). Working memory contributes to the Stroop and general cognitive speed is strongly implicated in the task, especially in older adults (Strauss et al., 2006). The age adjustment is included in the Golden version

of the test, utilised here, to avoid penalising older adults on the basis of slowed cognitive speed which largely explains slightly decreased speed in older adults (Strauss et al., 2006). The Stroop also relates to the Raven's Progressive Matrices, which is a timed test of fluid intelligence; the correlation may result from the requirement of speed in the administration of both the Stroop and the Raven's Matrices test. Overall, the Stroop is a sensitive measure of the inhibition of dominant responses with fair construct validity (Miyake et al., 2000; Strauss et al., 2006) and adequate reliability. Strauss and colleagues caution that the Stroop should not be applied in clinical settings without corroboration from similar tasks (2006). A computerised version of the Stroop, which allowed for easy administration and scoring, was available and utilised at first; this was later replaced with the manual version. The Stroop, WCST and IGT all had the advantage of being aesthetically pleasing and entertaining.

The Wisconsin Card Sorting Test (the WCST) was employed as a widely used test of abstract reasoning, concept formation, the ability to shift and maintain attentional set (Alvarez & Emory, 2006; Barceló & Knight, 2002; Barry & Petry, 2008; Jurado & Rosselli, 2007) and "the ability to inhibit previously correct responses" (Phillips & Henry, 2008, p. 63). Miyake et al. (2000) have, via latent variable analysis, shown that the WCST, while tapping various executive and non-executive functions, may nevertheless be used as a measure of the executive function shifting. Strauss et al. (2006) report that the test is best applied as a measure of general executive functioning, but it was used here (guided by Miyake et al., 2000) as a measure of shifting. Test-retest coefficients tend to be low as learning occurs throughout the test and is applied in the second administration (Strauss et al., 2006). Learning, however, is not able to fully account for the low correlation; stability on the task appears to be low. As noted above, the WCST is a complex task which may be used to provide a shifting score, but which includes a variety of other executive and non-executive tasks and repeated administration is likely to involve the executive functions (applied most on novel tasks) less. The

WCST has high inter-rater reliability (Heaton, Chelune, Talley, Kay & Curtiss, 1993), but it is recommended that the WCST not be used for clinical purposes without revision because of low predictive validity (Bowden et al., 1998).

On the computerised WCST, participants were required to sort 128 cards according to one of three categorisation criteria (Hebben & Milberg, 2002); the criteria changed after the participant had sorted ten cards per category correctly (V. Anderson, 1998). Once 128 cards had been presented, the task ended. The WCST scores analysed here were the number of Conceptual Level Responses and Perseverative Errors. This is because a single factor underlies performance on the WCST, so the calculation of additional scores is unnecessary (Bowden et al., 1998). The use of two scores, however, was justified as the focus of the scores is quite different: the Conceptual Level Responses indicates whether or not the individual understood the test and its rules, whereas the Perseverative Errors score is the index of shifting required (and as the score which is considered most sensitive to frontal lobe dysfunction; Miyake et al., 2000).

The 40 item version of the AIM (Affect Intensity Measurement) was administered; individuals rated themselves on each item on a six point response scale anchored by 'Never' and 'Always'; high scores indicated high affect intensity (Larsen, 2009). Several items on the AIM were reverse-scored; following standards practice, such items were reversed before analysis. Internal consistency reliabilities have ranged from 0.9 to 0.94; split-half correlations have fallen between 0.73 and 0.82; and test-retest coefficients over one and three months of 0.8 and 0.81 respectively have been found (Larsen, 2009). No significant correlation with social desirability, or positive and negative mood frequency has been found and validity is sound (Diener, Sandvik & Larsen, 1985; Larsen, 2009). Gender differences on the AIM have been found (women tend to score higher than

men); conflicting results have been found regarding age differences on the AIM (Diener et al., 1985). Given the sample of risk takers versus non-risk takers, a significant difference on the basis of risk taking was expected.

Ethics

The individuals approached were informed, in verbal and written form, of the study's aims and methods. The nature of the battery was such that individual variability in performance was normal and expected; perfect scores were not possible, and poor scores did not imply damage or abnormality in a neurologically normal population. This was stated in the subject information sheet and was repeated for any individual experiencing anxiety during testing. Anxiety during testing was not anticipated as the tests were designed to be aesthetically pleasing and entertaining rather than strenuous; minor anxiety was found, and was alleviated in this way. The participants were of an age to provide informed consent; and no deception was employed. There was no foreseeable harm to the participants in the testing process. No individual feedback was given to those who completed the tests; individuals were told that access to summary results for the groups would be granted to participants and these summary results were to be disseminated to the Harley-Davidson branches involved and the golf club chosen for further distribution to interested members. For those individuals who met one of the exclusion criteria, the researcher explained that the individuals were not of the population under study (for example, for individuals in the non-risk taking group who engaged in risky behaviours like skydiving) or that the results would misrepresent the executive functions of the individual involved. Similarly, individuals excluded for meeting other exclusion criteria were informed that their data was not comparable to or not representative of the target population. While anonymity could not be achieved (the researcher became familiar with the participants), confidentiality was guaranteed and all personal and identifying information has been removed from the final report.

Data Analysis

In order to answer the research questions, certain pre-requisite analyses had to be conducted. These consisted of assessing the internal consistency reliability of the AIM, establishing the basic traits of the data as a whole and testing the assumptions required for the use of parametric analysis. The research question was then answered using correlation analyses appropriate to the nature of each scale. Potential outliers were identified via scatter analysis, and results of the statistics excluding these outliers are reported in conjunction with data from the full sample and excluded from further analyses. Answers from the open-ended question included in the demographics inventory were read to ensure that no individuals cited views inconsistent with the categorisation of riding a Harley-Davidson as risk taking behaviour. No significant contestation of the operationalisation of risk taking was evident. The reasons provided have been reported in the Harley-Davidson Group section.

Results

Process

Data analysis commenced once data cleaning and checking was complete. The reasons that Harley-Davidson rider gave in the demographics inventory for their choice of the brand are presented (in the section The Harley-Davidson group). Certain pre-requisite analyses were conducted: the basic traits of the data were established (under the section Data profile), the assumptions required for the use of parametric analysis were tested (in the second subsection of the Data profile section) and the Summary statistics subsection presents the internal consistency reliability of the AIM and the simple statistics for the groups. All statistics were produced using the statistical program SAS. Scatter diagrams were produced and analysed to locate any influential outliers and assess the impact of these data points on the results (Outliers section); these outliers

were then excluded from the dataset. The descriptive data of the IGT, Stroop, WCST and AIM results are presented below in the Data profile section. The first research question (is there a relationship between risk taking, executive functioning and affect intensity?) was answered using correlation analysis (in the section Relationships between the variables); the second research question (does the performance of risk takers differ significantly from that of non-risk takers on an inhibition task, a shifting task, a decision making task and an affect intensity task?) was answered using Mann-Whitney U tests, the non-parametric version of the two independent sample t-test (in the section Comparison of Means).

Various scores were created for the purpose of data analysis. The first of these was IGT Group, a score which split the sample into those who succeeded in the Iowa Gambling Task (those who achieved a final score of $2000 or more and were given the score 1) and those who did not (individuals who achieved a final score of less than $2000 and were given the score 0). Following the author (Larsen, 2009) the AIM scores were split into a Positive, a Negative, a Neutral and a Total score. The Stroop produced the Interference score as a measure of inhibition. From the WCST, the Perseverative Errors, and Conceptual Level Responses scores were analysed. In the risk-taking group, a score (Motorcycle Status) was created to distinguish, at the request of the Harley-Davidson riders themselves, and on the basis of the researcher's observations, between those motorcycle riders whose first Harley-Davidson had been purchased less than 5 years after their first motorcycle and those whose ownership of, and interest in, motorcycles extended to or beyond this 5 year period. This was meant to distinguish between riders with a long term interest in motorcycles in general who had then invested in a Harley-Davidson, and those who had purchased a Harley-Davidson after hitting a milestone in life with little or no previous interest in motorcycles. This distinction was frequently made by the riders themselves, and the researcher speculated that other differences may emerge from the distinction. Another score, called Additional Risk, was created for

the Harley-Davidson group, and was an index of how many risk behaviours in addition to riding a Harley-Davidson the risk takers reported (with a score of 1 signifying that no behaviours in addition to riding a Harley-Davidson were reported, and a score of 2 signifying that some additional risk behaviours were reported).

Data Profile

The risk taking group was designated group 1; the non-risk taking group was designated group 2. Group 1 (risk takers) included 3 females and 17 males, between the ages of 32 and 64, 18 of whom were right handed and 2 left handed. Group 2 (non-risk takers) included 3 females and 15 males, between the ages of 30 and 59, of whom 14 were right handed, 2 were left handed, and 2 were ambidextrous. In terms of education, 2 in group 1, and 1 in group 2 had not achieved matric, 4 in group 1, and 6 in group 2 had a matric qualification, 6 in group 1, and 8 in group 2 had a matric and further qualifications which were not formally recognised university degrees, and 8 in group 1, and 3 in group 2 had formally recognised university qualifications in addition to matric. Below, the collected data are described and the results for all statistics pre-requisite to the analyses which answer the two research questions are reported. While the researcher did have expectations regarding the performance of risk takers, the exploratory nature of the current study indicated non-directional statistical hypotheses and two tailed tests throughout.

The Harley-Davidson group.

The reasons given by individuals in the risk taking group (group 1) for purchasing a Harley-Davidson rather than any other brand of motorcycle or car ranged from financial reasons (such as a good resale value; *n* = 5), through the fun of riding (*n* = 2) and the experience of the ride (including its sound and feel, *n* = 6), to the freedom (*n* = 3) and individuality (via customisation to the rider's

needs) of the bike (*n* = 1). Several bikers cited the family and interesting people that come along with the bike (*n* = 6), while 2 individuals cited the reliability and technology of the bike itself. Seven individuals noted that the culture surrounding the motorcycle was instrumental in their choice (one dubbed Harley-Davidson riders, "a human race on its own"), with one of these citing the organised events as an important motivator and another citing a need for a life change that the brand answered. Four of the Harley-Davidson riders cited good marketing strategies as a prime motivator for their choice of the brand with one individual calling the brand iconic and one other individual referring to the nostalgia for the past that the brand invokes. Five cited the image and lifestyle attached to riding as key in their choice, with one citing a desire "to be part of a legend". One noted a mid life crisis was his reason, while another claimed to have always wanted one, and another who claimed he wanted to buy one "to fulfil a life-long dream". Still another noted that the brand is a symbol of success: "[the brand is] aspirational (sic) to those who have reached some pinnacle of success in life and wish to reward themselves". Another claimed he "had enough cash to spend on a toy" and the Harley-Davidson was recommended by a colleague as an alternative to a sports car (another risky choice).

While this qualitative data points to a rich discourse surrounding the brand and the experience of the ride which deserves its own analysis (see Schrembi, 2008 for one such article), the purpose of collecting this data was to check that the riders did not dispute the operationalisation of Harley-Davidson as a risk taking activity. Five individuals noted that the Harley-Davidson's emphasis on power and cruising rather than speeding was a motivator for choosing the brand, one of the group claimed he had looked for a motorcycle which was "less risky [and] more relaxing", and another had sought a motorcycle to "tame [his] speed lust". Nevertheless, none of the participants disputed the operationalisation of Harley-Davidson riders as risk takers; each of the individuals who noted the focus on power and cruising went on to comment, in conversation with the researcher

after testing was complete, on how risky motorcycle riding was. One individual claimed the Harley-Davidson was the least safe brand of all motorcycles available. So, although there was some dispute as to where riding a Harley-Davidson would fall in terms of level of risk, no individual claimed that riding a Harley-Davidson was safe, and all acknowledged the risk inherent in riding any motorcycle.

Testing the parametric assumptions.

This section tests the assumptions required for parametric tests and the next describes the identification and exclusion of the outlying points in the Outliers section. The summary statistics are presented for each group and for each test in the Summary Statistics section, and lay the foundation for the analysis of the correlations and comparison of means tests. Outliers have been excluded from the summary statistics, presented last in the Data profile section.

The researcher assessed the normality of the data by creating histograms representing the distribution of scores across the groups, and by producing summary statistics and distribution statistics (Shapiro-Wilk) for each instrument within and across the two groups. Only those indices which were interval scaled could be analysed with parametric analysis techniques. The Age, IGT (Total and Blocks 1-5), AIM (Total, Positive, Negative and Neutral), Stroop Interference and both Wisconsin scores were interval scaled, while the Risk, Motorcycle Status, IGT Group and Education scores were ordinal and the Gender score was nominal. The other assumptions required for the use of parametric statistics were normality of distribution, homogeneity of variance across groups (assessed with Levene's test), additive means and a random and independent sampling strategy (Huck, 2008; Parsons, 1978). Given the combined group size of N=38, the Shapiro-Wilk test of normality was deemed appropriate for assessing the distribution of the data; this test is suitable for small to medium sample sizes while the Kolmogorov-Smirnov test of normality is appropriate for

larger samples (Rees, 2001). The test of normality, while not definitive in and of itself is a useful index of the normality of the distribution (Rees, 2001); decisions regarding the normality of the data were made using the histograms, simple comparison of the median and mean summary statistics and the Shapiro-Wilk statistic. The IGT total and the IGT block 1 scores were not normally distributed, nor was the Perseverative Errors score on the WCST (as expected on this type of index). All other interval scaled scores (and those ordinal scaled indices). A series of Levene's tests indicated that all scores met the assumption of equal variance between groups.

Non-parametric analyses were deemed appropriate for use throughout for three reasons: firstly, the group sample sizes were unequal. Non-parametric analyses are more appropriate than parametric analyses when sample sizes are low or unequal across groups (Huck, 2008); in such cases, the parametric *t*- and *F*-tests become less resistant (less robust) to violations of core assumptions such as distribution normality (Huck, 2008). The violation of core assumptions makes the *t*- and *F*-tests function differently, which in turn makes interpretation of the results difficult (Huck, 2008). Secondly, the assumption of a random sampling strategy was violated, although the sample was independent. A purposive non-probability sampling strategy using the snowballing technique was utilised. Finally, the number of variables to be analysed was such that simplicity and clarity of the results was valued more than the use of the most powerful statistics available. In addition, the widespread assertion that parametric tests are more powerful than non-parametric tests is not always warranted (Huck, 2008). The other assumption required for a parametric analysis, namely that means were additive, was not directly tested once this decision was made (Huck, 2008). As such, correlation analyses with less stringent assumptions were chosen, and the comparison of means test deemed suitable was the Mann-Whitney U test (the equivalent of the Wilcoxon Rank Sum test).

The correlations chosen when examining the relationship between each pair of variables were selected on the basis of the scale of measure of the scores and whether or not they were dichotomous. All dichotomous variables were naturally rather than artificially so and the correlation coefficients were chosen with this in mind. The correlation table (Table 6, in Appendix M) shows the correlation coefficients for the variables under study; the majority of coefficients were computed using Spearman's Rank Correlation Coefficient while those between the variables Gender and Group were phi correlations and those between the variables IGT Group, Gender and Group with the remaining variables were point biserial correlations on the basis of the natural dichotomy of these three variables and the continuous nature of the other variables under study. The correlations are discussed under the section Relationships between the variables; group differences are examined under the section Comparison of means.

Outliers.

Table 1 (see Appendix L), shows the summary statistics and sample sizes of the variables under study. Several of these variables (IGT Total, the Stroop score and Perseverative Errors) have reduced sample sizes. The reduction was the result of the exclusion of outliers. An outlier was defined as any point at least three standard deviations away from the sample mean; scatter diagrams of the variables which had outliers in their distributions were produced and are presented in Appendix K. Histograms and Shapiro-Wilk statistics of the indices including these outliers were produced after the points had been excluded; while the IGT Total score distribution did not become normal after the extreme score had been removed, the distributions of the Stroop Interference and Perseverative Errors scores did become normal after outlier exclusion.

The demographics of the individuals whose scores were removed were studied in order to determine whether systemic differences existed between these individuals and the rest of the sample. No differences were evident in the data collected for the purposes of this study, although unrecorded differences may exist; as such, the exclusion of all scores from these individuals could not be justified. However, the exclusion of the outlying points was justified as outliers may render the measures of central tendency less representative of the data, making interpretation difficult. In addition, correlation coefficients and comparison of means test statistics may be over- or under-estimated in the presence of outliers (Huck, 2008). Outliers were found in the IGT Total, Stroop Interference, and Perseverative Errors distributions.

Core Results

The summary statistics, correlations and comparison of means for each test are addressed in this section. Table 1 is presented in Appendix L and holds the summary statistics for the full group tested (*N*=38). Table 2 contains the correlation matrix and is presented in Appendix M. Relationships between the variables were computed across the total sample (*N*=38) with the groups representing different levels of risk: individuals from group 1 (*n*=20) represented the risk takers and those from group 2 (*n*=18) the non-risk takers. This avoided the reduction in power than would follow from analysing the relationships in each group separately (Huck, 2008). Relationships which were significant are reported.

Appropriate correlation coefficients were computed for each variable pair in the main dataset and are displayed in Table 2 (in Appendix M). The phi correlation coefficient was applied when relating the variables Group and Gender because both of these variables were naturally dichotomous. The point biserial correlation was deemed appropriate when correlating the variables

Group, Gender and IGT Group with the rest of the variables under study. Although Pearson's Product-Moment Correlations could have been applied to some of the remaining correlation pairs, the assumption of a linear rather than a monotonic relationship (made when using the Pearson's Product-Moment correlation) was deemed inappropriate. As such, the Spearman's rho correlation was chosen for use between the remaining variables on the basis of its less stringent assumptions.

Comparison of means tests were calculated using two sided Mann Whitney U scores on a *t* approximation (SAS uses the equivalent Wilcoxon Rank Sum Scores). As with the correlation coefficients, the level of significance chosen was $\alpha = .05$. A series of Mann Whitney U tests were run and several significant differences were found. Post hoc calculations were apparently implicated, yet the Bonferroni-Dunn test, if run, would not find any significant differences when used after these Mann Whitney U tests. As such, the Bonferroni-Dunn adjustment was not appropriate in this case. Because of the number of tests run, it would be expected that the overall (experimentwise) alpha value would be larger than 0.05; this is not the case, however, because the instruments used were independent. As such, the overall type one error rate was still controlled at $\alpha = .05$.

In terms of demographics, the variable Age was not significantly related to any of the variables in the study. There was no significant difference between the groups in the variable Age ($p > .05$). The Handedness variable had insufficient variance for meaningful investigation, and so the variable was not subjected to further analysis. Investigation into the variables Gender and Education, in conjunction with the expectations of difference introduced in the literature, indicated that more extensive analysis was required. When examined and compared, no clear-cut differences were found between the groups in career level, although the non-risk takers did tend towards operational, management jobs in retail and advertising. In terms of career, the risk takers tended

towards financial, project and management consulting. Both groups, however, had managing directors and entrepreneurs, and senior and junior managers; the distinction was not unambiguous and may have been an artefact of the locations from which the samples were derived. As such, pending further research in similar samples, the researcher cannot claim that the groups differed systematically in career level or field.

Education was significantly related to the AIM Total score (r_s= -.352, p= .03). There was no significant difference between the risk taking (group 1) and non-risk taking (group 2) groups in terms of education (p> .05). In terms of gender, group 1 included 17 males and 3 females, while group 2 included 3 females and 15 males. There was no significant difference between the groups in terms of gender (p> .05; see Table 2 in Appendix M for exact coefficients). Gender was significantly related to the IGT Block 3 score (r_{pb}= 0.373, p= .021) and to the Conceptual Level Responses score (r_{pb}= -0.356, p= .028) of the WCST. Neither of these variables differed significantly by gender on a Mann Whitney U test, however.

In the risk taking group (group 1), the Motorcycle Status score was examined. This introduced a distinction that split the group of Harley-Davidson riders into long term riders (15 individuals) and short-term riders (5). Because the Motorcycle Status score was dichotomous, a point biserial correlation was deemed suitable. The Motorcycle Status score was correlated with the test scores from the IGT, Stroop, WCST and AIM, and with the Additional Risk score created to distinguish between those riders whose only risk behaviour was riding a motorcycle and those whose risk behaviours were more numerous.

Only two of these relationships were significant: the correlation between the AIM Negative subscale and Motorcycle Status (r_{pb} = .496; p=.026), and the relationship between the Additional Risk variable and Motorcycle Status (r_{pb} = 0.471; p= 0.036). Two other relationships with the Motorcycle Status score were noteworthy. The relationships, while not significant ($p \geq .05$), were moderately strong at r_{pb} = -0.392 with the Stroop Interference Score, and r_{pb} = 0.415 with the AIM Neutral score. The results relevant to the research questions for the psychometric tests are presented below.

Table 3: Summary statistics by group for the IGT

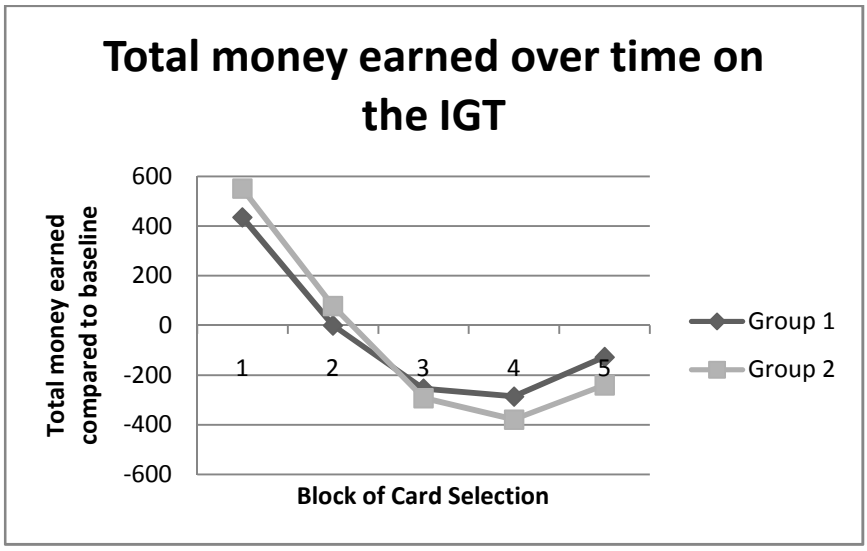
Variable	Group	N	Mean	Std Dev	Median	Minimum	Maximum
IGT Block1	1	20	2435.000	670.006	2250	1200	3400
	2	18	2550.000	528.594	2650	1200	3300
IGT Block2	1	20	2000.000	864.657	1975	550	3750
	2	18	2077.780	748.179	2400	750	3000
IGT Block3	1	20	1745.000	945.961	1725	-150	4000
	2	18	1706.940	671.686	1550	850	3500
IGT Block4	1	20	1713.750	802.688	1675	350	3450
	2	18	1620.830	893.533	1625	-150	4000
IGT Total	1	20	1872.500	825.175	1650	-150	3500
	2	17	1758.820	867.690	1425	975	4500

The summary statistics relating to the Iowa Gambling Task for the two groups are shown in Table 3 above. The variable IGT Group was created to present the natural distinction between those who had succeeded in the task and those who had not, in numerical form. Eight individuals in group 1 (risk takers) and five individuals is group 2 achieved an IGT Total score equal to or exceeding the

initial $2000 loan (and so, succeeded in the task), twelve risk takers, and thirteen non-risk takers (group 2) had an IGT Total score under this amount.

As per standard practice, the IGT scores were totalled and split into 5 blocks of 20 scores (with the cumulative score for Block 5 being the total score for the IGT) and a plot of the blocks was produced for each group. This is found in Figure 1 below.

Figure 1: Line plot of the IGT wins and losses across the sample



For the correlations between the blocks of card selections within the IGT, see Table 2 in Appendix M. The first three blocks of card selections on the IGT largely involve discovering how the task works, and forming preferences for specific decks; as such, only the correlations with the fourth and final blocks are likely to be stable. These correlations are reported here; correlations between the first three blocks of selections and the other indices are available in Table 2, Appendix M. IGT Block 4 was significantly related to the Perseverative Errors scores (r_s= -0.334, p= 0.043). The IGT

Total score was significantly related to AIM Neutral (r_s= 0.411, p= .012), and the WCST score Conceptual Level Responses (r_s= -0.399, p= .014). Finally, IGT Group, which is derived from IGT Total, was significantly related to AIM Neutral (r_{pb}= 0.330, p= .043) and Conceptual Level Responses (r_{pb}= -0.423, p= .008). There was no significant relationship between the total IGT score and group membership. Comparison of means revealed that there were no significant differences between the two groups on any score on the IGT (IGT Blocks 1-4, IGT Total and IGT Group).

After the computerised version of the Stroop Colour-Word Interference Test was replaced with the manual version, the total sample size for the Stroop from the risk taking group (group 1) was reduced from n=20 to n=13. This reduction (from 38 to 31 as the total number of people tested for the Stroop) led to a drop in the power of the analysis such that only a correlation of r=.54 instead of r=.5 would be found at a 90% power coefficient. The sample size and power were reduced further by the exclusion of an outlier. As discussed in the Procedure section, the Failure to Maintain Set score was correlated with the available Stroop Interference scores to test the suitability of the former score as a proxy for the latter. The resulting coefficients of r=.16 and r_s=.08 on the Pearson's and Spearman's correlation procedures respectively showed that the Failure to Maintain Set score was not a suitable proxy. The power difference caused by the exclusion of these seven scores was, however, minimal; the remaining scores were retained in further analyses.

The table below (Table 4) shows the Stroop summary statistics for the two groups. Because the raw Stroop score (rather than t-converted scores) were used, a high score on the Stroop implies that the participant was less susceptible to interference. Group membership was significantly related to the Stroop Interference score (r_{pb}= -0.402, p= .028). Comparison of means tests,

however, showed that the two groups were not significantly different in their performance on the Stroop.

Table 4: Summary statistics by group for the Stroop

Variable	Group	N	Mean	Std Dev	Minimum	Maximum	Median
Stroop	1	12	4.193	4.578	-4.058	11.102	5.197
Interference	2	18	0.805	3.423	-5.750	7.000	1.169

While there are 6 principal scores typically derived by the Wisconsin Card Sorting Test, only two were analysed: the Perseverative Errors score as a measure of prefrontal cortex, or executive function, and the Conceptual Level Responses as a measure of understanding on the test. A table of the summary statistics for the two groups on the WCST is presented below (Table 5). The Perseverative Errors score was significantly related to the Conceptual Level Responses (r_S= -0.471, p= .003), as would be expected. No significant differences between the groups were found on either score of the WCST.

Table 5: Summary statistics by group for the WCST

Variable	Group	N	Mean	Std Dev	Minimum	Maximum	Median
Perseverative	1	20	16.900	8.220	16.50	5	34
Errors	2	17	16.529	8.889	16.00	3	30
Conceptual Level	1	20	57.750	26.441	57.00	16	101
Responses	2	18	58.667	26.113	60.50	6	103

The raw and standardised internal consistency reliability coefficients of the Affect Intensity Measurement, across the groups, were α=.83. This increased slightly when certain items were removed but never above α=.84. In group 1, the overall raw and standardised Cronbach's alpha coefficients were α=.72 and α=.73 respectively; in group 2, the coefficients were both α= .88. See Table 6 for a breakdown of scores for the groups and the sample as a whole.

Table 6: Summary Statistics for the AIM

		N	Mean	Standard Deviation	Minimum	Maximum	Median
AIM Positive	Group 1	20	3.612	0.491	3.250	4.875	3.654
	Group 2	18	4.192	0.600	3.167	4.958	4.154
AIM Negative	Group 1	20	3.617	1.166	2.769	4.385	3.500
	Group 2	18	3.519	0.972	3.385	5.231	3.667
AIM Neutral	Group 1	20	3.916	0.343	1.667	5.667	3.913
	Group 2	18	4.154	0.478	2.000	5.000	4.075
AIM Total	Group 1	20	4.119	0.489	3.400	4.575	4.250
	Group 2	18	4.213	0.487	3.150	4.950	4.271

For the relationship between scores within the AIM, see Table 2 in Appendix M. In terms of relationships between the AIM and the other indices, the variable Group was significantly related to the AIM Negative Score (r_{pb}= 0.479, p= .002). In addition, there was a significant difference between the two groups on their Negative Affect Intensity Score (p= 0.011). No other significant differences between the groups were found.

Discussion

Discussion of Results

The researcher aimed to assess specific executive functions in a socially functional risk taking sample and a comparable non-risk taking sample in order to answer the following questions: is there a relationship between risk taking, executive functioning and affect intensity, and does the performance of risk takers differ significantly from that of non-risk takers on an inhibition task, a shifting task, a decision making task and an affect intensity task? The first research question was addressed with correlation analyses; the second research question was answered by means of Mann Whitney-U tests.

The statistics related to the demographics variables are reviewed and interpreted first, as this has been the pattern throughout the report. The results of the correlations with gender are reported for use in further research on the psychometric properties of the instruments used. This is followed by interpretation, in order of administration, of the tests utilised and the implications of the results reported. Relationships were classified as moderately strong when their coefficients ranged from .3 to .5, strong when the coefficient ranged from .5 to .7 and very strong when the coefficient was .7 or above.

In terms of demographics, the Age and Handedness variables were excluded from further analysis early on. The variable Age was not related to any other variable in the study, and did not differ across groups. The Handedness variable was excluded on the basis of insufficient variance for meaningful interpretation. Education was moderately strongly negatively related to the AIM Total score implying that individuals who were more educated tended to report, or experience, less intense emotions. This may be a result of the focus in higher education (especially in the sciences)

on factual evidence over affective cues (Evans et al., 2004). Damasio's Somatic Marker Hypothesis, for example, was poorly received and is counterintuitive to many because the integral role it allocates to the emotions in decision making is contrary to the popular teaching that separates emotional concerns from good decision making (A. R. Damasio, 1994). This may be an interesting follow up study in terms of the AIM's validity and regarding the relation between education and the construct underlying the AIM.

The two groups did not differ in terms of Gender and no significant differences were found between any test scores on the basis of Gender (although there were only 6 females in the total number of individuals tested). Gender did, however, relate positively and moderately strongly to the IGT Block 3 score implying that males tended to lag behind females in this block of card selections, perhaps as a result of a resistance to affective cues emerging from socialisation in a culture which links masculinity with reason, and femininity with increased emotionality (Bennett, 2007). Overman (2004) speculated that females tended to avoid negative cues more diligently than males on the IGT. It is possible that females simply responded more swiftly to emotional cues, while males tended to value affective feedback less. This advantage was short-lived, however, and the results of the IGT were comparable for the rest of the decision making task. Given the small number of females to males in this sample, further research is implicated before conclusions regarding gendered differences may be made.

Gender was also related negatively, and moderately strongly, to the Conceptual Level Responses score implying that males tended to display better understanding of the WCST. There was no relationship between Gender and Perseverative Errors however, so this relationship did not imply any difference in prefrontal cortex functioning. It is possible that different factors affect

performance in males and females, or males were better able to pick up on cues in the instructions given. Again, further research may explain this relationship. The same is true for the significant relationships between gender and the IGT Block 3; further research is implicated. While gender differences in the AIM scores have been found in the literature (with women reporting higher affect intensity than men), no relationship with gender or difference between the genders in the AIM scores was found in the current sample.

Within the risk taking group, the Motorcycle Status and Additional Risk scores were correlated with the other indices. There was a significant relationship between Motorcycle Status and negative affect intensity. The strength of this positive and moderate-to-strong relationship suggests that individuals who have been risk takers for longer display significantly less intense negative affective states. The moderately strong positive relationship between Additional Risk and Motorcycle Status implies that the long term riders tended to participate in risk behaviours in addition to riding a Harley-Davidson. It is conceivable that individuals who report, or experience, less intense negative affect are more likely to engage in risk behaviours or that the strength of the relationship between risk taking and AIM Negative scores may increase as the number of risk taking behaviours engaged in increases. These conjectures require further testing.

In the interpretation of the test data below, emphasis has been placed on the findings of the Iowa Gambling Task because the pattern of results suggests that the groups chosen were similar on a third variable capable of influencing the results. As has been the pattern throughout, the IGT, Stroop, WCST and AIM results are interpreted in order.

In the literature, it was reported that the relationships between the executive functions rarely exceeded *r*= .4. This pattern is repeated here: the fourth block of IGT card selections is moderately strongly positively related to the WCST Conceptual Level Responses score, and negatively related to the Perseverative Errors score. As such, higher scores on the fourth IGT block were related to the index of understanding on the WCST and negatively related to the index of errors in prefrontal function. The final IGT score related positively and moderately strongly to the AIM Neutral score and the WCST Conceptual Level Responses score, as did the IGT Group score. Reminiscent of Miyake et al.'s task impurity problem (in which a decision making task, for example, required the involvement of other executive functions and non-executive functions), the IGT was related to the shifting task and the affect intensity measurement utilised here. In the current sample, as elsewhere in theory and practice (P. J. Anderson, 2008; Jurado & Rosselli, 2007; Stuss & Alexander, 2000), executive function was not a unitary concept. While not directly relevant to answering the research questions, these correlations are interesting in terms of the implications they may have for the specificity and validity of the indices involved.

According to A. R. Damasio (1994), neurologically normal individuals start by sampling all four of the decks, before beginning to favour the two high risk decks in the early blocks. While this strategy, utilised over the first two to three blocks of 20 card selections yields high rewards, it yields even higher penalties, leading to a net loss. Participants were then, in blocks 4 and 5, expected to favour the low risk decks with occasional samplings of the high risk decks. Neurologically normal individuals, therefore, should show an early preference for the high risk decks and a later preference for the low risk decks resulting in a net gain over the starting loan. Imperfect but steadily increasing associations between the blocks of IGT card selections and the total IGT score should result and were expected because the scores are cumulative across the blocks and the individual was expected

to learn throughout the task and modify his/her selection behaviour accordingly. This latter pattern was not found (see Table 2, Appendix M).

In the current research, it was expected that neurologically normal risk takers would select more cards from the high risk decks than individuals in the non-risk taking comparison group. The individuals included in the sample did indeed show an early preference for the decks with high reward and even higher penalties (see Figure 2). Directly contrary to the researcher's expectations, however, both groups (instead of just the non-risk taking group) began, in blocks 4 and 5, to select more cards from the less risky decks. The gain was not great enough to break even or succeed in the task, but was a significant improvement over early behaviour. Thus, the two groups' selection pattern resembled that predicted by A. R. Damasio et al. (1994) with the exception that neurologically normal participants (in general) are expected to end the task with a net gain rather than a net loss over the starting loan ($2000).

There was no relationship between IGT performance and group membership and no difference between the groups on any IGT score. As a key indicator of decision making, this was surprising. That neither group produced the performance expected of neurologically normal populations indicates that the groups were either not neurologically normal, and systematically differed on some neurological variable not screened for in the current study, or more plausibly, that both groups differed on some third variable that affects decision making (and possibly other executive functions). One potential third variable is that both groups included financial risk takers, which would affect performance on a monetary task such as the IGT. One consideration lends support to this conjecture: the groups did not appear to be systematically different in their career choice, although the non-risk takers did tend towards operational and management jobs in retail

and advertising while the risk takers appeared to orient towards financial, project and management consulting. This trend was not unambiguous, and inferences from it should be cautious. Two alternatives are available: it is possible that the method of selecting individuals (purposive and snowball sampling) may have produced an atypical group of golfers not representative of the target population. In addition, it is possible that the trend in performance found in international samples is not applicable in the current sample. In sum, no difference in decision making was found between the groups.

The initial use of the computerised Stroop resulted in the loss of seven participants' scores. Two techniques were proposed, and one was implemented, in order to compensate for this loss: first, emphasis was placed on the strength (rather than statistical significance) of the correlations between the Stroop Interference score and the other test results. The second proposed alteration was to include a subscale score of the WCST as a proxy for the Stroop Interference score. The score in question, Failure to Maintain Set, was recommended as a correlate of the Interference score which would act as a substitute or proxy for the missing Interference scores. The researcher correlated the remaining Stroop scores with the Failure to Maintain Set score; the resulting coefficients of r=.16 and r=.08 on the Pearson's and Spearman's procedures respectively, meant this proposal was not instituted.

The significance of the relationship between group membership and the Stroop Interference score suggests that the two were associated, yet this association did not produce a significant difference between the groups. This may be attributed, in part, to moderate power. While the loss of power in identifying relationships was minimal, in a comparison of means the loss of seven participants (and an additional outlier) would be much more substantial (with the smaller group

including only 12 individuals). Overall, group 1 (the risk takers), appeared to be less susceptible to interference over the task than the non-risk takers (group 2). In order to confirm that this relationship translates into a significant difference in a larger sample, however, further research is needed.

As expected, the Wisconsin Card Sorting Test Conceptual Level Responses score correlated negatively, and moderately strongly, with the Perseverative Errors score. So, as individuals understood the task better, they tended to make fewer errors of the perseverative type. As noted above, Gender was related significantly to the Conceptual Level Responses score, introducing the need for further research into the factors that determine performance on the WCST by males and females. No significant group differences were found on the basis of WCST scores and thus no difference in shifting ability between risk takers and non-risk takers can be inferred. As in the IGT results above, however, the possibility that the non-risk taking group included financial risk takers implies a need for further testing in risk takers and a true non-risk taking comparison group.

The overall internal consistency (α=.83) of the AIM was good, although it was lower than the coefficient (α=.9 to .94) reported in the literature (Larsen, 2009). The difference between the two groups' internal consistency coefficients points to greater variability in the risk taking group when it comes to reports of Affect Intensity; the non-risk taking group was more uniform and consistent and thus achieved higher internal consistency coefficients. No items, when deleted, caused a large enough increase in internal consistency to necessitate their removal. One significant difference by group in AIM Negative was found; the other subscale scores failed to achieve significance. Since the AIM Negative, Positive and Neutral scores are subscale scores of the Total, the difference between the groups partially explains the finding that the internal consistency coefficient found here was

lower than that reported in the literature. As such, the lowered internal consistency is a result of the sample, rather than the being a failing of the test itself.

The relationship between group membership and the AIM Negative score was a moderately strong positive relationship which indicated that risk taking was associated with lower negative affect. There was a significant difference between the groups on the AIM Negative subscale, with Harley-Davidson riders reporting (and by inference, experiencing) less intense negative emotions. This may imply that risk takers receive less negative feedback from risk behaviours as a result of lower negative affect; this could contribute to the initiation and continuation of risk taking. Determining whether this conjecture is accurate would have implications for rehabilitation and treatment of the risk taker typically studied in social science research: the substance user. The detection of a significant difference on this score has implications for the second research question; the identification of a significant relationship had implications for the first research question.

The findings presented above are sufficient to answer the first research question: is there a relationship between risk taking, executive functioning and affect intensity? There was a moderately strong negative relationship between the Stroop Interference score and risk taking that implies that risk takers were less subject to cognitive interference and thus better equipped in inhibition tasks. Further research is required to test whether this relationship translates into a significant difference between a risk and non-risk taking sample. This is worthy of further investigation, as it may contribute towards an understanding of why individuals choose to engage in risky behaviours. This relationship is counterintuitive when applied to substance users as the group of risk takers typically studied in social science research; substance users exhibit weak rather than strong inhibition. It is possible that the two types of inhibition (response inhibition, and inhibition of habitual behaviour) are separable and inferences should not be made across types of inhibition. Alternatively, the risk

behaviours motorcycle riding and substance use may differ more than expected on the basis of available literature. Nonetheless, this finding is valuable in terms of the implications it has for further research.

Since there were no significant correlations between group membership and the IGT and WCST scores (and pending follow up research), the researcher cannot conclude that there was a relationship between risk taking and decision making or shifting in the current sample. There was, however, a significant and moderately strong relationship between group membership and negative affect intensity suggesting that Harley-Davidson riders display or report less intense negative affect. The relatively mild negative emotional peaks that Harley-Davidson riders report, in conjunction with the heightened inhibition associated with risk taking, may contribute to the initiation and continuation of risk behaviours.

On the basis of results reported above, the second research question (does the performance of risk takers differ significantly from that of non-risk takers on an inhibition task, a shifting task, a decision making task and an affect intensity task?) may now be answered. Risk takers and non-risk takers performed significantly differently on the Negative scale of the Affect Intensity Measurement with risk takers reporting lower negative affect intensity. Risk takers and non-risk takers did not perform differently on the other scales of the AIM, or on the inhibition task, the shifting task or the decision making task. Further research should reveal whether or not the relationship between the inhibition index and risk taking translates into a significant difference between risk takers and non-risk takers.

The hypothesis that there is a fundamental difference between risk takers and non-risk takers which explains their group membership cannot be disproven on the basis of these results. It seems likely that there is a basic difference between risk takers and non-risk takers which explains the choice to be one or the other; however, this difference may not lie in the executive functions. This cannot be conclusively decided here; further investigation is needed. The difference found between the groups on Negative Affect was interesting, and may go some of the way to accounting for group membership.

This report identified a gap in the literature and started to answer the first of two concerns: whether or not the relationship between risk taking and executive function endured beyond a substance using population, and, if the relationship did persist, whether or not risk taking had an effect on executive function, or vice versa. The second concern is the chicken or egg problem; it was not the intention of the report or its author to address this but to set the stage for this question to be answered; this task is left to future researchers. The first concern, prerequisite to the second, was the focus here and from it emerged the two research questions that have now been addressed.

Contribution to Knowledge

The current study paved the way for research to address a gap in the literature. The chicken or egg problem involves two distinct steps, and this study addressed the first step. The first step or concern involved an examination of the relationships between the variables of interest, while the second involved the determination of causal relations between these variables. Two relationships directly of interest to the research questions were identified: that between group membership and the negative affect intensity score, and that between group membership and the inhibition index.

Only the former relationship translated into a significant difference. Additional relationships with gender will be of interest to those examining the validity of the instruments applied.

There is insufficient evidence in the current study to show that the risk taking groups differed in terms of inhibition, shifting or decision making. Further research (in a larger sample, with greater power) is implicated, particularly in terms of inhibition following the significant relationship found between group membership and the Stroop score. Exploratory research is not intended to prove a point conclusively, but rather to guide future investigation in the area. This research achieves this goal by identifying the relationships between negative affect intensity, cognitive interference and risk taking as worthy of further study.

The assumption made by the researcher throughout was that there is a difference between risk takers and non-risk takers. The inference made, and tested, here is that the difference lies in executive functions which are fairly stable across the lifespan. When the researcher screened the non-risk taking sample for risk behaviours, the questions concerned risk behaviours and substance use in the last 5 years. While necessary to obtain a sample, this practice belies the stability of the risk taker's choice of risky behaviour that is implied in the conceptualisation of the study. The stability of the hypothesised basic difference between the risk taking groups is implied in the distinction between the individuals in the two groups, yet is not carried through to its logical conclusion: that an individual is always, or never, a willing risk taker. The insignificance of differences between the groups may have been the result of one of three issues: the categorisation of individuals as risk takers or non-risk takers may have been flawed, the difference between risk takers and non-risk takers may lie outside the variables under study here, and there may not be any

clear distinction between risk takers and non-risk takers: the risk taking trait may be best represented on a continuum.

Other problems which may have affected the output of the research include the moderate sample size and resulting moderate power of the statistics which have been noted as a limitation throughout; the use of self-report data, the flaws of which are well-documented, in the AIM; or possible sampling bias in the snowballing sampling strategy and in the interaction between the participants and the researcher which may have affected how representative the sample was of the target population, and thus affected ecological validity. Further, more extensive research in a larger sample may address these issues.

The expectations which emerged from the literature were as follows: risk takers were expected to experience more interference (and so, weaker inhibition) on the Stroop, make more risky decisions (and thus make a net loss on the IGT), commit more Perseverative Errors on the WCST and report higher overall affect intensity than the non-risk takers. While risk takers did make a net loss on the IGT, they did not (in this group) make more risky decisions than their non-risk taking counterparts, implying that some third factor influenced decision making. The risk takers also failed to differ significantly on the Stroop or WCST; they did, however, show less intense negative affect and a relationship was found between the Stroop and group membership which may imply that a difference between the groups does exist and would emerge in a larger sample.

Directions for Future Research

The negative relationship between the total AIM score and education may be of interest in future studies. This correlation suggests that those individuals who are more educated report or experience less intense affect than those with less education. A similar relationship has been found on the decision making tool, the IGT (Evans et al., 2004): individuals who were more educated displayed less advantageous decision making than those with fewer educational achievements. Further research may imply the need to include a less rational, more emotion-based component in lessons relating to life skills in the educational system.

Several variable pairs were significantly related in the sample, without there being significant differences between the groups. The relationship between the Stroop Interference score and group membership is one example. Further research may discover whether or not this is simply the result of lowered power as a result of a limited sample size. This may have to be done in a different but comparable (and possibly risk taking) sample as the population (as defined here) from which the sample was drawn is limited in number and difficult to access. Gendered differences on the Conceptual Level Responses score and on the IGT may also be worthy of further investigation.

The operationalisation of Harley-Davidson riders as risk takers, and golfers as non-risk takers overlooked the possibility that individuals in both groups could be financial risk takers. This third variable may account for the lack of significant differences between the groups on the decision making and shifting tasks, and further research should include and account for this characteristic.

The correlation between the Motorcycle Status index and the AIM Negative score, in conjunction with the significant relationship with the Additional Risk variable implies that further research on long-term risk takers (like those 15 individuals who were long-term riders and who were also more likely to engage in risk behaviours other than motorcycle riding) may be of value. The results found here imply that there may be a relationship between long-term risk taking and negative affect intensity.

In both the Motorcycle Status correlations and the overall correlations with group membership, there was a moderately strong negative correlation with the Stroop Interference score which was only significant in the case of group membership. Further research with a larger sample is necessary because each of these correlations implied that the Harley-Davidson riders were less subject to cognitive interference. This finding would have implications for the second research question investigated here and for the study of risk taking and executive function in general. Further research would also determine whether or not the significant relationship between the Stroop Interference score and group membership translate, in a larger group, into a significant difference between risk and non-risk taking groups. This would imply that Harley-Davidson riders differ more extensively than previously thought from substance users, as the latter group typically display poor or weak inhibition. Again, more extensive research is needed.

Tests of executive function have been found to suffer from problems of construct validity. The constructs under investigation in these tasks require the involvement of a host of executive and non-executive functions. An alternative measurement method is that of neural imaging studies which provides information on the structure and activation of various areas of the brain in specific

tasks and in the resting state. Neural imaging is costly, however, and not necessarily suitable for exploratory research. New methods for economically assessing the executive functions are needed.

Conclusion

The first research question regarding the existence of a relationship between risk taking and executive functioning or affect intensity was answered using correlation coefficients appropriate to the nature of each variable pair. Given the current sample size and nature, the researcher cannot conclude that there is a relationship between risk taking and executive functioning, in general. There was, however, a significant and moderately strong relationship between group membership and negative affect intensity suggesting that Harley-Davidson riders display or report less intense negative affect. There was also a relationship, but no significant difference, between risk taking and cognitive interference suggesting that risk takers are less subject to cognitive interference. In conjunction, these imply that risk takers are less subject to (or simply report) less intense negative affect and displayed stronger inhibition. Further research into these relationships will be of value.

While differences between the groups on variables which are not under study here may exist, the researcher can tentatively conclude that there were no differences between the groups on the executive functions decision making and shifting. Further research is required to determine whether there is a difference between the interference and risk taking variables; pending further research, and on the basis of this sample, there is no difference. In terms of the chicken or egg question, the current study implies that the relationship found between substance use (as risk taking) and executive function does not persist in the chosen group of risk takers (Harley-Davidson riders). The relationship between inhibition (on the Stroop) and risk taking, however, is worthy of

future investigation, as is the importance of the difference between the groups on negative affect intensity.

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Appendix A: Participant Information Sheet for Harley-Davidson riders

School of Human and Community Development

Private Bag 3, Wits 2050, Johannesburg, South Africa

Tel: 27 (0)11 717 4524/5 Fax: 27 (0)11 717 4556

Email: nomonde.gogo@wits.ac.za

Hi! My name is Laura Harris, and I am conducting research for the purpose of obtaining a Masters degree at the University of the Witwatersrand. My area of focus is the high level thought processes of successful individuals who choose a particular recreational activity: motorcycle riding. My research supervisor, Enid Schutte, and I would like to invite you to participate in this study.

Participation in this research entails completing an electronic battery of psychological tests. The tests will, together, take 20 to 40 minutes to complete. Participation is voluntary, and no individual will be advantaged or disadvantaged in any way for choosing to complete or not complete the battery. While questions about your personal circumstances are included, no contact details are required and confidentiality between the researcher and you as a participant is guaranteed. The information you provide will only be seen by me and my research supervisor; I will compile the information and produce data for the group. I will then analyse this data and provide the Harley-Davidson dealership with a summary of results for the group for any participant interested in feedback. No individual feedback can be given. Please note that many individuals find these tests challenging and no damage or abnormality is implied by this.

If you choose to participate, please complete all the test items carefully and honestly. You are free to withdraw your consent to participate at any time and no negative consequences will follow. Your participation would be greatly appreciated; the information you provide will be kept confidential.

Note that I am conducting this research in my own capacity; the Eagle Wind Harley-Davidson branch is not invested in this research.

Kind regards,

Laura Harris Please feel free to contact me on: 072 487 5650

or Laura.Harris@students.wits.ac.za

Appendix B: Participant Information Sheet for Golf Club Members

School of Human and Community Development

Private Bag 3, Wits 2050, Johannesburg, South Africa

Tel: 27 (0)11 717 4524/5 Fax: 27 (0)11 717 4556

Email: nomonde.gogo@wits.ac.za

Hi! My name is Laura Harris, and I am conducting research for the purpose of obtaining a Masters degree at the University of the Witwatersrand. My area of focus is the high level thought processes of successful individuals who choose a particular recreational activity: golf. My research supervisor, Enid Schutte, and I would like to invite you to participate in this study.

Participation in this research entails completing an electronic battery of psychological tests. The tests will, together, take 20 to 40 minutes to complete. Participation is voluntary, and no individual will be advantaged or disadvantaged in any way for choosing to complete or not complete the battery. While questions about your personal circumstances are included, no contact details are required and confidentiality between the researcher and you as a participant is guaranteed. The information you provide will only be seen by me and my research supervisor; I will compile the information and produce data for the group. I will then analyse this data and provide the golf club with a summary of results for the group for any participant interested in feedback. No individual feedback can be given. Please note that many individuals find these tests challenging and no damage or abnormality is implied by this.

If you choose to participate, please complete all the test items carefully and honestly. You are free to withdraw your consent to participate at any time and no negative consequences will follow. Your participation would be greatly appreciated; the information you provide will be kept confidential.

Note that I am conducting this research in my own capacity.

Kind regards,

Laura Harris Please feel free to contact me on: 072 487 5650

or Laura.Harris@students.wits.ac.za

Appendix C: Participant Consent Form

I, _____, consent to participate in this study: I will complete the information sheet and psychological tests presented to me by the researcher, Laura Harris.

I understand that:

- Participation is voluntary
- That I may leave out any question that I would prefer not to answer
- I may withdraw my consent at any time with no negative outcome for me
- My responses will remain confidential
- No positive or negative consequences will follow from choosing to, or not to, participate

Signed: _____ Date:_____

Assigned Participant Number: _____

Appendix D: The Demographics Inventory (for the Harley-Davidson Group)

General:

Assigned Participant Number: _____

Gender (Tick): Male ☐

Female ☐

Age in years: _____

Handedness (Tick): Right ☐

Left ☐

Ambidextrous ☐

Highest Level of Education Attained: _____

Current Career Title(s) and Field: _____

_____

_____

Medical History (please tick next to any condition diagnosed during your lifetime):

Head injury resulting in loss of consciousness: ☐

Neurological disorder: ☐

Psychiatric or psychological disorder excluding those related to drug use: ☐

Drug dependence disorder (including alcohol): ☐

Colour blindness: ☐

If you ticked any of these, please explain: _____

_____

_____

Risk Behaviours (If yes, please specify):

Extreme Sports in the Last 5 years ☐

_____

Recreational Substance (Drug) Use in the Last 5 years ☐

_____

Other behaviours that you, or others, would classify as risky ☐

_____

Harley-Davidson information:

Age at which you first purchased any brand of motorcycle (including Buell): _____

Age at which you first purchased a Harley-Davidson: _____

Are you an active and participating member of the Johannesburg Harley Owners Group (HOG)? _____

Are you an active and participating member of the Steel Wings club? _____

Currently Owned Harley-Davidson Models (If more than six, please note total number and list most recently acquired models):

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

In a paragraph or more, please explain why you chose a Harley-Davidson rather than any other motorcycle or vehicle.

(please continue over the page)

Appendix E: The Demographics Inventory (for the Golf Club Group)

General:

Assigned Participant Number: _____

Gender (Tick): Male ☐

Female ☐

Age in years: _____

Handedness (Tick): Right ☐

Left ☐

Ambidextrous ☐

Highest Level of Education Attained: _____

Current Career Title(s) and Field: _____

_____

_____

Medical History (please tick next to any condition diagnosed during your lifetime):

Head injury resulting in loss of consciousness: ☐

Neurological disorder: ☐

Psychiatric or psychological disorder excluding those related to drug use: ☐

Drug dependence disorder (including alcohol): ☐

Colour blindness: ☐

Risk Behaviours (If yes, please specify):

Extreme Sports in the Last 5 years ☐

_____

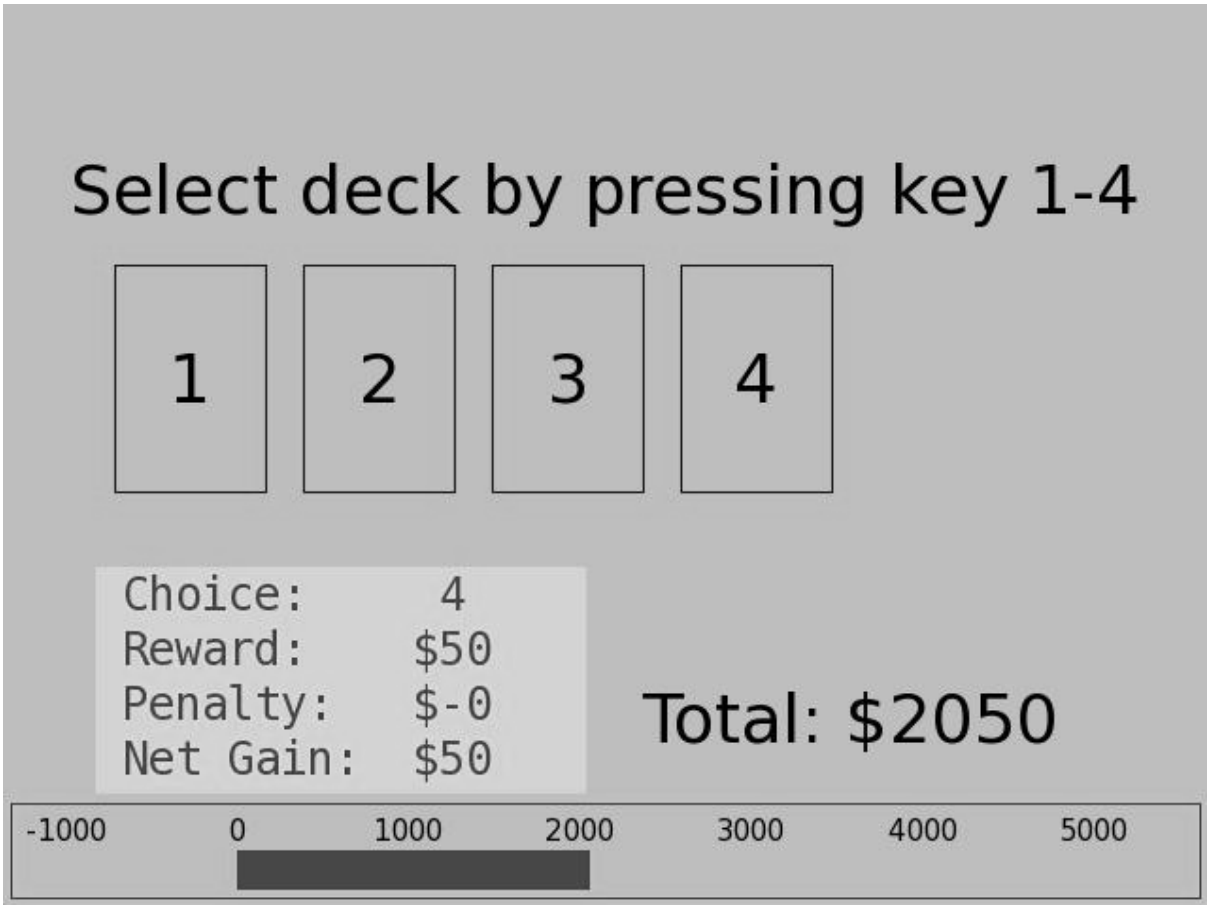
Recreational Substance (Drug) Use in the Last 5 years ☐

_____

Other behaviours that you, or others, would classify as risky ☐

_____

Appendix F: Sample item from the Iowa Gambling Task (IGT) computerized version



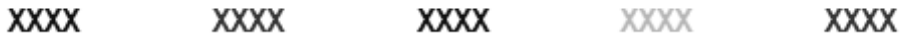
Appendix G: Sample item from the Stroop Colour-Word Interference test (Stroop) computerized version

Appendix H: Sample row from each condition of the manual Stroop

Condition 1: Words in black

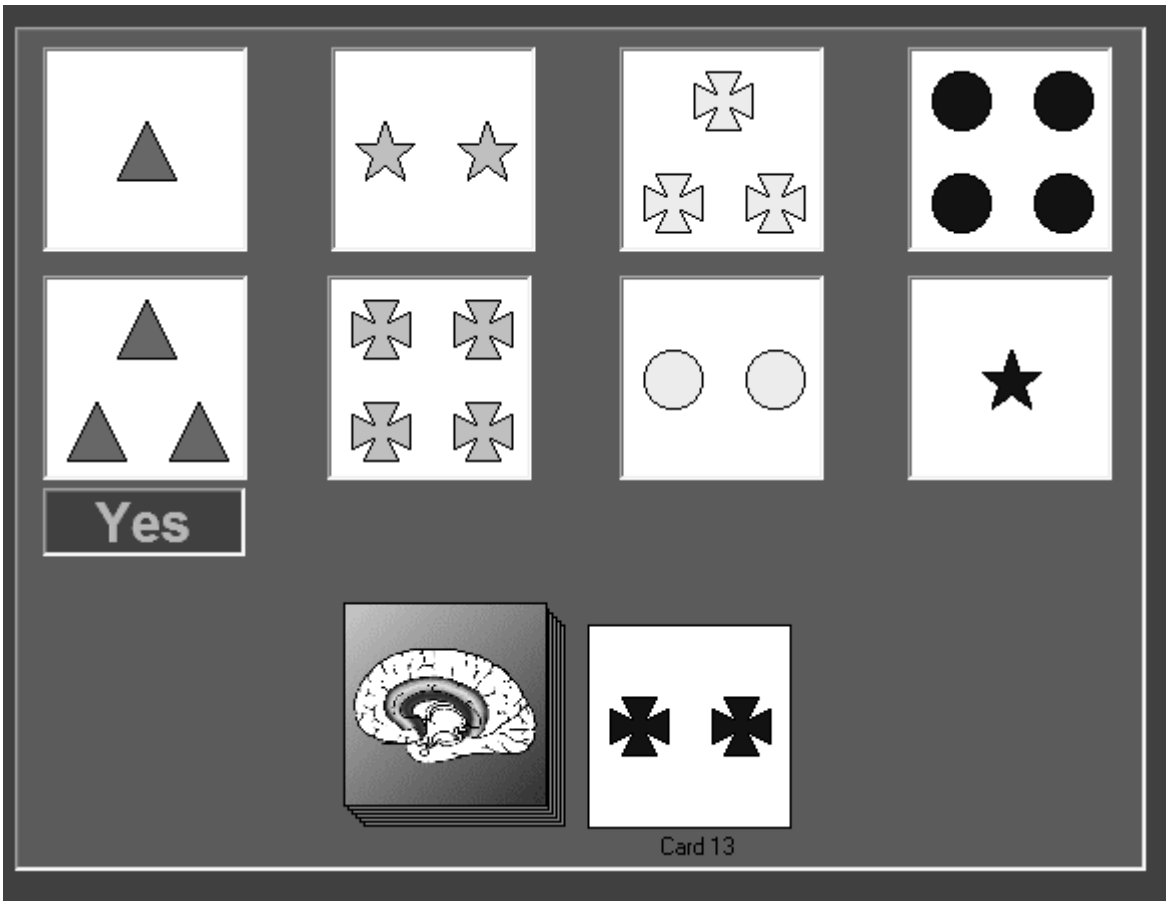
RED BLUE GREEN RED BLUE

Condition 2: Non-words in colour (red, green or blue)



Condition 3: Words written in a colour contrasting with the colour named

Appendix I: Sample item from the Wisconsin Card Sorting Test (WCST) computerized version

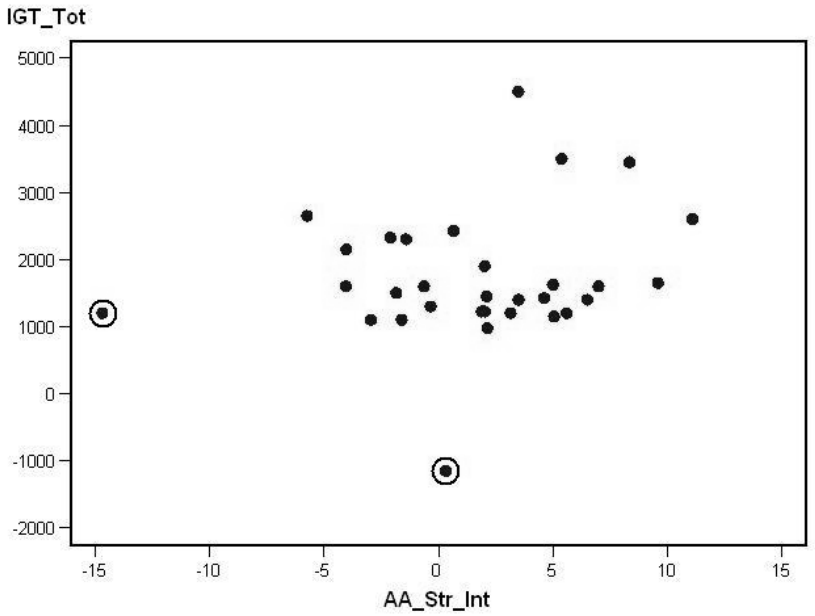


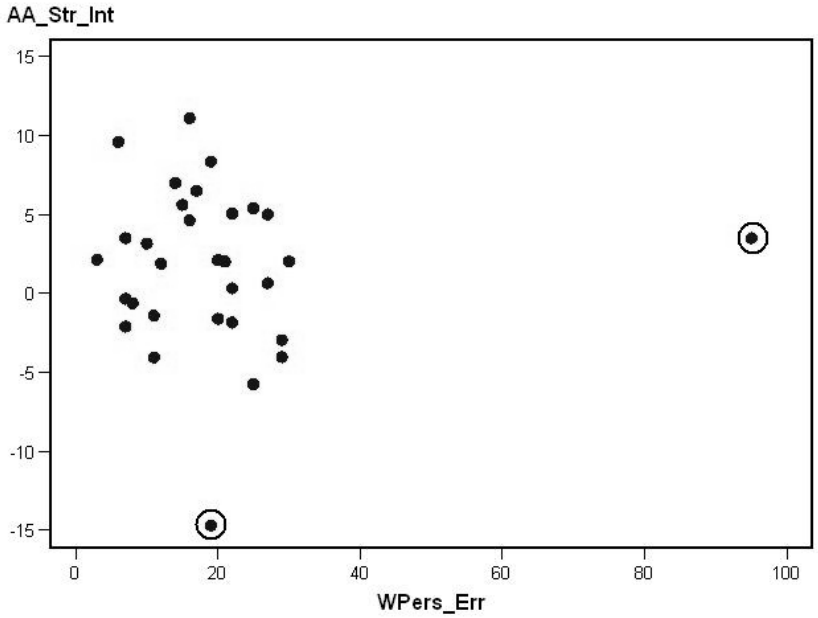
Appendix J: Sample Item from the Affect Intensity Measurement (AIM) computerized version

1= Never; 2=Almost Never; 3= Occasionally; 4= Usually; 5= Almost Always; 6= Always

Item 1. _____ When I accomplish something difficult I feel delighted or elated.

Appendix K: Scatter diagrams with outliers circled





Appendix L: Table 1 - Summary Statistics

Simple Statistics

Variable	Label	N	Mean	SD	Median	Minimum	Maximum
Gender	Gender	38	1.158	0.370	1.000	1.000	2.000
Age	Age	38	46.895	8.272	47.500	30.000	64.000
Edu	Edu	38	2.868	0.935	3.000	1.000	4.000
IGT Block1	IGT_Blck1	38	2489.470	601.901	2550.000	1200.000	3400.000
IGT Block2	IGT_Blck2	38	2036.840	801.661	2225.000	550.000	3750.000
IGT Block3	IGT_Blck3	38	1726.970	816.808	1650.000	-150.000	4000.000
IGT Block4	IGT_Blck4	38	1669.740	836.603	1650.000	-150.000	4000.000
IGT Total	IGT_Tot	37	1820.270	835.037	1600.000	-150.000	4500.000
IGT Grp	IGT_Grp	38	0.342	0.481	0.000	0.000	1.000
AIM Positive	AIM_Pos	38	4.163	0.484	4.250	3.167	4.958
AIM Negative	AIM_Neg	38	3.887	0.613	3.885	2.769	5.231
AIM Neutral	AIM_Neu	38	3.570	1.065	3.667	1.667	5.667
AIM Total	AIM_Tot	38	4.029	0.424	4.000	3.150	4.950
Stroop Interference	AA_Str_Int	30	2.160	4.203	2.068	-5.750	11.102
Perseverative Errors	WPers_Err	37	16.730	8.415	16.000	3.000	34.000
Conceptual Level Responses	WCon_resp	38	58.184	25.933	60.500	6.000	103.000

SD refers to the standard deviation.

Appendix M: Table 2 - Correlation Coefficients

(The correlation coefficients between Group and Gender were phi correlations while those between Group, Gender, IGT Group and the remaining variables were point biserial correlations. Finally, the main body of the table consists of Spearman's rho correlations. The dark grey highlighted coefficients are addressed in the text, while the light grey highlighted p-values are significant at α=.05.)

Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	Group	Gender	Age	Edu	IGT_Blck1	IGT_Blck2	IGT_Blck3	IGT_Blck4
Group	1.000	0.023	-0.078	-0.150	0.097	0.049	-0.024	-0.056
		0.892	0.641	0.368	0.564	0.770	0.888	0.738
	38	38	38	38	38	38	38	38
Gender	0.023	1.000	-0.056	0.140	0.202	0.053	0.373	0.123
	0.892		0.737	0.402	0.224	0.753	0.021	0.462
	38	38	38	38	38	38	38	38
Age	-0.078	-0.056	1.000	0.108	-0.174	-0.138	0.099	0.198
	0.641	0.737		0.520	0.295	0.409	0.553	0.233
	38	38	38	38	38	38	38	38
Edu	-0.150	0.140	0.108	1.000	-0.010	0.000	0.128	0.140
	0.368	0.402	0.520		0.950	0.999	0.442	0.403
	38	38	38	38	38	38	38	38
IGT_Blck1	0.097	0.202	-0.174	-0.010	1.000	0.271	0.419	0.120
	0.564	0.224	0.295	0.950		0.100	0.009	0.474
	38	38	38	38	38	38	38	38
IGT_Blck2	0.049	0.053	-0.138	0.000	0.271	1.000	0.536	0.455
	0.770	0.753	0.409	0.999	0.100		<.001	0.004
	38	38	38	38	38	38	38	38
IGT_Blck3	-0.024	0.373	0.099	0.128	0.419	0.536	1.000	0.548
	0.888	0.021	0.553	0.442	0.009	<.001		<.001
	38	38	38	38	38	38	38	38
IGT_Blck4	-0.056	0.123	0.198	0.140	0.120	0.455	0.548	1.000
	0.738	0.462	0.233	0.403	0.474	0.004	<.001	
	38	38	38	38	38	38	38	38

Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	IGT_Tot	IGT_Grp	AIM_Pos	AIM_Neg	AIM_Neu	AIM_Tot	AA_Str_Int	WPers_Err	WCon_resp
Group	-0.069	-0.129	0.099	0.479	-0.047	0.284	-0.402	-0.022	0.018
	0.686	0.442	0.556	0.002	0.781	0.084	0.028	0.896	0.915
	37	38	38	38	38	38	30	37	38
Gender	0.183	0.144	0.224	0.145	-0.075	0.207	0.254	-0.039	-0.356
	0.279	0.388	0.177	0.384	0.656	0.212	0.176	0.820	0.028
	37	38	38	38	38	38	30	37	38
Age	0.065	0.132	-0.288	-0.115	-0.179	-0.258	0.015	0.142	-0.245
	0.702	0.431	0.080	0.490	0.283	0.118	0.938	0.402	0.139
	37	38	38	38	38	38	30	37	38
Edu	-0.084	0.103	-0.288	-0.170	-0.230	-0.352	0.195	0.035	0.121
	0.621	0.539	0.079	0.307	0.164	0.030	0.303	0.839	0.470
	37	38	38	38	38	38	30	37	38
IGT_Blck1	0.016	0.174	0.106	0.222	-0.232	0.160	0.072	0.345	-0.250
	0.923	0.296	0.525	0.180	0.161	0.338	0.707	0.036	0.130
	37	38	38	38	38	38	30	37	38
IGT_Blck2	0.565	0.612	0.279	0.165	0.114	0.293	0.112	0.018	-0.307
	<.001	<.001	0.090	0.323	0.496	0.074	0.554	0.915	0.061
	37	38	38	38	38	38	30	37	38
IGT_Blck3	0.262	0.365	0.247	0.393	-0.042	0.357	0.359	0.066	-0.154
	0.118	0.024	0.135	0.015	0.801	0.028	0.052	0.698	0.355
	37	38	38	38	38	38	30	37	38
IGT_Blck4	0.284	0.361	0.074	0.133	-0.083	0.071	0.342	-0.334	-0.084
	0.089	0.026	0.660	0.425	0.622	0.672	0.064	0.043	0.616
	37	38	38	38	38	38	30	37	38

Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	Group	Gender	Age	Edu	IGT_Blck1	IGT_Blck2	IGT_Blck3	IGT_Blck4
IGT_Tot	-0.069	0.183	0.065	-0.084	0.016	0.565	0.262	0.284
	0.686	0.279	0.702	0.621	0.923	<.001	0.118	0.089
	37	37	37	37	37	37	37	37
IGT_Grp	-0.129	0.144	0.132	0.103	0.174	0.612	0.365	0.361
	0.442	0.388	0.431	0.539	0.296	<.001	0.024	0.026
	38	38	38	38	38	38	38	38
AIM_Pos	0.099	0.224	-0.288	-0.288	0.106	0.279	0.247	0.074
	0.556	0.177	0.080	0.079	0.525	0.090	0.135	0.660
	38	38	38	38	38	38	38	38
AIM_Neg	0.479	0.145	-0.115	-0.170	0.222	0.165	0.393	0.133
	0.002	0.384	0.490	0.307	0.180	0.323	0.015	0.425
	38	38	38	38	38	38	38	38
AIM_Neu	-0.047	-0.075	-0.179	-0.230	-0.232	0.114	-0.042	-0.083
	0.781	0.656	0.283	0.164	0.161	0.496	0.801	0.622
	38	38	38	38	38	38	38	38
AIM_Tot	0.284	0.207	-0.258	-0.352	0.160	0.293	0.357	0.071
	0.084	0.212	0.118	0.030	0.338	0.074	0.028	0.672
	38	38	38	38	38	38	38	38
AA_Str_Int	-0.402	0.254	0.015	0.195	0.072	0.112	0.359	0.342
	0.028	0.176	0.938	0.303	0.707	0.554	0.052	0.064
	30	30	30	30	30	30	30	30
WPers_Err	-0.022	-0.039	0.142	0.035	0.345	0.018	0.066	-0.334
	0.896	0.820	0.402	0.839	0.036	0.915	0.698	0.043
	37	37	37	37	37	37	37	37
WCon_resp	0.018	-0.356	-0.245	0.121	-0.250	-0.307	-0.154	-0.084
	0.915	0.028	0.139	0.470	0.130	0.061	0.355	0.616
	38	38	38	38	38	38	38	38

Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	IGT_Tot	IGT_Grp	AIM_Pos	AIM_Neg	AIM_Neu	AIM_Tot	AA_Str_Int	WPers_Err	WCon_resp
IGT_Tot	1.000	0.788	0.234	0.061	0.411	0.233	0.061	0.120	-0.399
		<.001	0.164	0.721	0.012	0.165	0.753	0.487	0.014
	37	37	37	37	37	37	29	36	37
IGT_Grp	0.788	1.000	0.121	0.022	0.348	0.159	-0.066	0.167	-0.426
	<.001		0.468	0.894	0.033	0.341	0.730	0.323	0.008
	37	38	38	38	38	38	30	37	38
AIM_Pos	0.234	0.121	1.000	0.206	0.410	0.837	0.283	-0.236	-0.117
	0.164	0.468		0.214	0.011	<.001	0.130	0.160	0.483
	37	38	38	38	38	38	30	37	38
AIM_Neg	0.061	0.022	0.206	1.000	0.340	0.652	-0.091	0.267	-0.154
	0.721	0.894	0.214		0.037	<.001	0.633	0.110	0.357
	37	38	38	38	38	38	30	37	38
AIM_Neu	0.411	0.348	0.410	0.340	1.000	0.586	-0.021	0.015	0.004
	0.012	0.033	0.011	0.037		<.001	0.911	0.928	0.980
	37	38	38	38	38	38	30	37	38
AIM_Tot	0.233	0.159	0.837	0.652	0.586	1.000	0.107	0.000	-0.167
	0.165	0.341	<.001	<.001	<.001		0.572	0.999	0.316
	37	38	38	38	38	38	30	37	38
AA_Str_Int	0.061	-0.066	0.283	-0.091	-0.021	0.107	1.000	-0.182	0.041
	0.753	0.730	0.130	0.633	0.911	0.572		0.346	0.828
	29	30	30	30	30	30	30	29	30
WPers_Err	0.120	0.167	-0.236	0.267	0.015	0.000	-0.182	1.000	-0.471
	0.487	0.323	0.160	0.110	0.928	0.999	0.346		0.003
	36	37	37	37	37	37	29	37	37
WCon_resp	-0.399	-0.426	-0.117	-0.154	0.004	-0.167	0.041	-0.471	1.000
	0.014	0.008	0.483	0.357	0.980	0.316	0.828	0.003	
	37	38	38	38	38	38	30	37	38